UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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SUBCOMMITTEE ON REGULATORY POLICIES AND PRACTICES

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CLOSED SESSION

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TUESDAY,

JULY 10, 2007

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The meeting was convened in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 10:30 a.m., Dr. William J. Shack, Chairman, presiding.

MEMBERS PRESENT:

WILLIAM J. SHACK	Chairman
SAID ABDEL-KHALIK	ACRS Member
GEORGE E. APOSTOLAKIS	ACRS Member
J. SAM ARMIJO	ACRS Member
MARIO V. BONACA	ACRS Member
MICHAEL CORRADINI	ACRS Member
THOMAS S. KRESS	ACRS Member
OTTO L. MAYNARD	ACRS Member

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NRC STAFF PRESENT:

ROBERT PRATO

JOCELYN MITCHELL

RICHARD SHERRY

JOSEPH JONES

JASON SCHAPEROW

JIMMY NEROKA

CHARLES TINKLER

JOHN MONNINGER

MIKE SHIU

ATA ISTAR

JEFF GAZOR

FAROUK ELTAWILA

DONALD DUBE

SELIM SANCAKTAR

HOSSEIN NOURBAKSH

CONTENTS

P R O C E E D I N G S

(1:28 p.m.)

CHAIRMAN SHACK: Well, since it's just us chickens here, I think we can start even though Dr. Kress isn't here yet.

Bob, it's back to you.

MR. PRATO: Okay. Good afternoon. We're going to continue on with the results session of our presentation.

We do have a guest in the audience, a gentleman from Peach Bottom. I'm sorry.

MR. GAIVER: Jeff Gaiver.

MR. PRATO: Jeff Gaiver. He's a Peach Bottom representative. Because we have a site representative and OGC has limitations as to what information we can relate to them, I'm going to be orchestrating the bulk of the presentation.

We're going to be presenting the Peach Bottom results first and I'll walk you through it. When we get to Surry's slides, we're going to skip by those slides, and then we'll go back after we're done with Peach Bottom and do the Surry results presentation.

We are pressing along on Peach Bottom. It is the first site that we visited. We have got all of their information and we're a little bit further ahead on Peach Bottom than Surry. So it's probably a good way to give you a better picture initially.

Before we get started, Jocelyn found an answer --

(Laughter.)

MR. PRATO: -- to the question on the dose conversions.

MS. MITCHELL: I'll do it later. I'll pick it up at my piece at the end.

MR. PRATO: Okay. So this is the agenda for this afternoon. Sequence selection will be covered by Rich Sherry. Preliminary accident progression insights will be handled by Jason Schaperow. Structural analysis will be presented by Ata Istar at the end. Emergency preparedness, again, Joe Jones will be filling in for Randy Sullivan, and then latent cancer fatality dose response model. We'll address that at the end, and that will be Jocelyn Mitchell who will present that.

DR. APOSTOLAKIS: So the reason why this meeting is closed is these are very preliminary?

MR. PRATO: Generally, yes, and it may impact the Commission's ability to make signals in the future. So we requested -- I forgot the exact terminology on it, but it's one of the set criteria for allowing the meetings to be closed.

We may also be touching on some security related issues with AIB, but that wasn't the main impetus for us requesting that this to be closed.

DR. APOSTOLAKIS: But eventually the final results will be public, correct?

MR. PRATO: Absolutely, yes, sir.

Rich.

MR. SHERRY: Okay. Next slide, Bob.

Basically, the way I'm going to present the results is for each of the two plans, Peach Bottom and Surry. First I'll show the results of the Level 1 CDF analysis after we grouped the sequences or grouped some similar sequences for the internal events initiators, initiated sequences.

Then I will go through and discuss each of the sequence groups which went forward to an evaluation of the containment system status or the status of containment systems for both the internal and external events.

Also, on the slides which show the sequence groups you'll show a CDF per year given in as like mid-ten to the minus seven or low ten to the minus seven. The reason we're using this terminology is because this represents our looking at both the SPAR model results and the plant PRA, okay, and making judgments based on our reviews about what we believe are the most appropriate representation or modeling of the sequences, and so what is the most representative core damage frequency.

For Peach Bottom after this review, essentially we found no sequence groups which were near or above the screening criteria of ten to the minus six per year, and in addition, there were no special sequences, for example, no containment bypass sequences which were above ten to the minus seven for internal events.

DR. APOSTOLAKIS: Rick.

MR. SHERRY: Yes.

DR. APOSTOLAKIS: Something that is on the high side of the ten to the minus eight like the sequence number three, is that considered near the cutoff?

MR. SHERRY: Well, that sequence would be judged against a cutoff at ten to the minus six because it does not represent a sequence which we would consider one that has a potential for a large release, for example, like a containment bypass sequence.

DR. APOSTOLAKIS: So this is before the screening?

MR. SHERRY: This is before the screening.

DR. ARMIJO: So everything would be screened out?

MR. SHERRY: Everything from the internal event initiated sequences would be screened out.

DR. APOSTOLAKIS: Even if you go by the CDF, it says here that the total CDF is low ten to the minus six, right? Is that the real CDF compared to the conclusion from the SPAR and --

MR. SHERRY: And plant PRA, yes.

DR. APOSTOLAKIS: So shouldn't the screening frequency, even if we accept that that should be on the basis of CDF, should it vary depending on how low the CDF is?

I mean, if I have a plan that has 310 to the minus four total CDF --

MR. SHERRY: You're saying would a screening criteria be more appropriate if it was some fraction or percentage of total CDF?

DR. APOSTOLAKIS: Right, right. Instead of a fixed number, again, assuming that this the appropriate criteria, which I have doubts.

MR. SHERRY: It would be appropriate, I

think, in one sense, but then it would lead to essentially differences in absolute screening values among different plants.

DR. APOSTOLAKIS: Of course, but right now you have a total CDF in the low ten to the minus six region. Your cutoff is ten to the minus six. I mean, no wonder --

DR. ARMIJO: End of story, yeah.

DR. APOSTOLAKIS: No wonder no sequence makes it.

DR. MAYNARD: Yeah, I guess I'm not excited about having a different one for each plant. For the type of study that this is and what it's trying to convey, I think you almost have to have a definitive number that you're using.

DR. APOSTOLAKIS: But you see none of them makes it.

CHAIRMAN SHACK: Well, he'll get to another slide.

(Laughter.)

MR. SHERRY: I'd just like to mention --

DR. APOSTOLAKIS: But this kind of frequency is just an issue of convenience that there is nothing magical about.

DR. CORRADINI: How low should you go

though?

DR. APOSTOLAKIS: I'm telling you for CDF typically a calculation goes about a factor of 1,000 below what you expect. So if you expect the frequency to be ten to the minus five, you include maybe sequences greater than ten to the minus eight. That's the more or less standard practice, but it's always relative to what you're trying to find. It's a means of saving time and effort. It's not a technical thing, and with the new computer codes now and the methods of BDDs and all that, you don't need any cutoff frequencies.

But this is an additional assumption here that it's ten to the minus six no matter what.

MR. SHERRY: Just one other thing I wanted to mention before I leave this slide is that in our early analysis we did identify one sequence which would exceed the ten to the minus six, one sequence group. However, after we've reviewed the plant PRA results and compared them, made judgments, we decided that the plant model was more in depth, more representative, and essentially we judged that their evaluation of the frequency was most appropriate.

I mention that because we had done some initial work on that sequence, and Jason will be using that as an example later on.

Next slide.

The one sequence group or sequence type that we judge to be above the threshold was an external event, principally seismic initiated, station blackout.

DR. APOSTOLAKIS: So all of the internal sequences are out.

MR. SHERRY: All of the internal sequences are screened out.

DR. APOSTOLAKIS: Okay.

MR. SHERRY: And this sequence basically has in-vessel injection early to the HPCI until some time at or after loss of DC power or possibly failure of room cooling, and --

DR. APOSTOLAKIS: But if you have an SBO, you have a loop, right? Why do you say loop and SBO curves?

MR. SHERRY: Well, loop is the initiator, and then SBO is --

DR. APOSTOLAKIS: It becomes an SBO.

MR. SHERRY: It becomes an SBO.

And for these particular sequences you lose AC power. Eventually you lose DC power. The assumption is no possibility of recovery, and so in the way of engineered safeguards you have only those which I said are dependent upon other power sources than AC power for at least -- and are available only for a limited period of time.

DR. APOSTOLAKIS: What is the mission time? You have already assumed that the batteries have been depleted. How long is that?

PARTICIPANT: Four hours.

DR. APOSTOLAKIS: Huh?

PARTICIPANT: Four to eight hours.

MR. SCHAPEROW: We'll talk a little bit more about that when we get to the accident progression part.

DR. APOSTOLAKIS: They keep postponing things.

(Laughter.)

DR. APOSTOLAKIS: Everything will be answered in the last five minutes. All right. Jason, you win.

MR. SCHAPEROW: Actually it's about two slides from now or something.

DR. CORRADINI: If I can ask a question I'll watch Charlie. Take all sharp objects away from Charlie.

I'm back to the internal with sequences

one and two which are in the mid-ten to the minus seven, so below your cutoff. Is there something uniquely different about those in terms of plan damage state or would it be captured within the station blackout from an external event?

The topmost sequence group is essentially characterized by the availability of essentially all your containment safeguards, drywall sprays, canned heat removal.

DR. CORRADINI: The top one.

MR. SHERRY: The top one.

DR. CORRADINI: Okay.

MR. SHERRY: So even if it would have gone forward as a circa sequence, it would have been, I think, very unlikely that you would get a substantial source term or early containment failure because of the fact that you had essentially all of your containment engineered safeguards.

DR. CORRADINI: The same thing with number sequence group two. I guess what I'm looking for is I guess, to be honest with you, numbers get me kind of twitchy down here in these low values. I'm rather looking for qualitative differences. There is something qualitatively different about these sequence groups than you might come up with from a station blackout sequence even though it was driven externally. If they're approximately the same and all you're doing is looking at consequence anyway.

MR. SHERRY: Well, I think I can say this in confidence, that the station blackout is certainly going to bind all of these. It's going to be more severe.

MR. PRATO: Okay. The next couple of slide are on Surry. Let's go to slide 11, please.

DR. APOSTOLAKIS: What did we learn from Slide 5?

MR. PRATO: That's the only sequence.

DR. APOSTOLAKIS: Yeah, but I mean the table. Did you learn --

MR. PRATO: That's going to set it up for Jason. That's what he's got left.

DR. APOSTOLAKIS: So PCS is not available because that's part of the sequence, but the safety relief valves are not part of the sequence, and you assume they're perfect. That's what you said earlier. Okay. Okay means they will work.

MR. SHERRY: Right.

DR. APOSTOLAKIS: With probability one.

MR. SHERRY: Unless Jason fails.

DR. APOSTOLAKIS: What's the difference

between not failed and available?

MR. SHERRY: The SRVs can have several failure modes. They can fail to open or they can fail opening, and I'm trying to indicate with a few words the fact that they're both not failed to open and --

DR. APOSTOLAKIS: Essentially you are saying these three are available when Jason does his work.

MR. SHERRY: Right.

DR. CORRADINI: So how can HPCI be available if I've depleted the batteries?

I'm sorry. I'm not good at that either.

MR. SHERRY: HPCI is available until --

DR. CORRADINI: Oh, until. Excuse me. I'm sorry.

MR. SHERRY: -- battery depletion.

DR. CORRADINI: I'm sorry. I'm sorry.

MR. SHERRY: That's why it's the so-called long term station blackout.

DR. CORRADINI: Sorry.

MR. SHERRY: You have injection fray while --

DR. CORRADINI: No problem. Thank you.

MR. TINKLER: We worked pretty closely with Rick and the folks doing this SPAR to look at issues of timing effect, which might not normally be looked at closely, but when you're trying to do a constance calculation and you're looking at timing and you're looking at timing of EP, all of those things become more important than --

DR. APOSTOLAKIS: Maybe instead of a table like this you should have time line to show this.

MR. TINKLER: The timing we'll discuss more in the accident progression, but --

DR. APOSTOLAKIS: I mean, a time line somewhere there would be useful.

MR. TINKLER: We worked with Rick to look at the issues of timing, as well as to look at the issues of whether or not any of these sequence groups, as Mike suggested, pose some unique sort of characteristic. Okay?

And we satisfied ourselves that none of the internal events pose anything that was so unique that it wouldn't have been covered by --

DR. CORRADINI: But you would be leaving it out and it might challenge it and cause an odd looking source term.

MR. TINKLER: And, in fact, as Rick said, many of them have containment systems which were operable.

MR. SHERRY: Okay. On to Slide 11.

DR. APOSTOLAKIS: Again, I'm sorry.

MR. SHERRY: Okay, sir.

DR. APOSTOLAKIS: This is the subcommittee. We're trying to understand as well. Could we go to slide 4?

This perennial issues of what is a sequence comes up. So if I look at the sequences, you have seven, nine, and ten all starting with loss of off-site power, right?

MR. SHERRY: Un-huh.

DR. APOSTOLAKIS: Seven, nine and ten, correct on Slide 4?

DR. CORRADINI: And two of the three are failure of SPC.

DR. APOSTOLAKIS: Yeah. So why on the one group?

MR. SHERRY: Actually eight is also --

DR. APOSTOLAKIS: Station blackout. You're right.

MR. SHERRY: -- initiated by loop.

DR. APOSTOLAKIS: So seven, eight, nine, and ten, should they be one group, one sequence?

MR. SHERRY: Not necessarily.

DR. APOSTOLAKIS: Are the consequences of loss of off-site power so different that it's worth having separate sequences?

MR. SHERRY: These are, again, sequence groups.

DR. APOSTOLAKIS: Yeah, but I mean why aren't these groups one super group with all four?

MR. SHERRY: Because they would have -- and I'm not sure of the details, but they have different systems available and failed or unavailable, and --

DR. APOSTOLAKIS: Well, even if one system is different you say they're different sequences?

MR. SHERRY: Well, depending on what the system is.

And I don't have the details of what separates these right now.

MR. SHIU: George, some of those differences are whether you have high pressure systems available or low pressure systems available, whether you have failure at high pressure, low pressure, for example, or you have failure of long-term heat removal. So these are kind of the different criteria that were used to group the sequences.

DR. APOSTOLAKIS: RCS depressurization was successful. One would have to really look carefully to identify the difference between the sequences. I mean, since you are using that kind of frequency, one has to be careful as to which sequence or group of sequences the frequency is referring to, and here are four sequences that appear to be fairly similar to each other.

I mean I can take the external event sequence and maybe subdivide it into four different sequences and go below the cutoff.

Why can't I do that? I think you need a story. I'm not saying that you did it on purpose, but you really need a convincing story why you keep these separate, why the seismic is one and not four. Because the definition of an accident sequence is not precise, right? It would be in terms of trains. It would be in terms of components. It would be in terms of systems, and there is an agreement in this agency that when we say accident sequence we mean the initiator and systems, front line systems.

But, again, you know, so telling a nice story about that would b every helpful here.

MR. SHIU: I think I want to repeat the fact that the way these sequences are made up was so that if we look down the line if we had to propagate these sequences into the Level 2 containment systems or the consequences, we can distinguish between the cardinal sequences with high pressure systems available or if it's a low pressure core melt or if it is a long term sequence where we fail RHR, for example.

So these sequences are picked so that we can distinguish between the system interactions towards the --

DR. APOSTOLAKIS: But the problem, Mike, is that you are eliminating them. That's the problem. If you were handling them in a different way, more power to you. But what you're saying is whew, ten of them out.

MR. PRATO: But if you had four low ten to the minus six, you're still going to be in ten to the minus seven which would be outside of our --

MR. SHIU: In this case it's --

DR. APOSTOLAKIS: Assuming that our criterion is correct and assuming that there are no other sequences that do this. All right.

DR. CORRADINI: All four of them that you picked though, just to take their side for a minute, they're cooking at high pressure just like the external event one. So the qualitative way in which the thing all goes to hell in a hand basket is similar.

DR. APOSTOLAKIS: With the external event.

DR. CORRADINI: Yeah, in terms of how the source term would be developed. That's my understanding of what it all means.

MR. SHIU: That's correct.

DR. CORRADINI: I was guessing you would argue them that way, but you didn't. So I thought I'd try that way.

MR. SHIU: We could argue in that way also. I mean the fact that these four actually subsume or are covered by the external events initiator.

DR. ARMIJO: If you hadn't had that external event and that's your criteria, what would you --

DR. APOSTOLAKIS: Sam, what did you say? I'm sorry.

DR. ARMIJO: If you hadn't had that external event that met your screening criteria, then what would you do?

(Laughter.)

DR. ARMIJO: Fall over?

DR. CORRADINI: Put another one at Philadelphia I'd say.

(Laughter.)

MR. ELTAWILA: This is Farouk Eltawila from Research.

When we proposed this program to the Commission, we said we are going to do a realistic analysis, and if the answer come that there is no sequences, that's going to cause risk, early fatality or it can surface out to report that finding. That's all what our mission is, you know, so that there's nothing wrong based on the screening criteria that the staff has selected. There are no scenarios that lead into early failure, early fatality or late kinds of fatality (phonetic).

DR. ARMIJO: I'm very glad about that, but that's a fact that I'm just saying for the purposes of this analysis it's all over in the first screen.

MR. ELTAWILA: If the plants have done enough modification to the plant and reduced the core damage frequency, we should acknowledge that and say they fixed the plant and the core damage frequency does not meet the criteria that we established and, therefore, there are no scenarios.

If the Commission wants to send us back to start working on it and take additional scenarios, we can do that, but right now there is nothing wrong with reporting the actual results.

DR. ARMIJO: Okay.

DR. APOSTOLAKIS: Silence does not mean agreement.

(Laughter.)

MR. TINKLER: I also want to say that this didn't all happen in a vacuum. We had other calculations, for example, and we discussed this with the committee a number of times for the BWRs that show that CRD injection flow rates are adequate to maintain core cooling. so when we looked at some of these sequenced groups, while these may show up in SPAR because of either a temporary or long-term loss of HPCI or low pressure injection, if we could see other systems were available and we did this when we thought we had an internal event that was close to our threshold, when we look in detail at the precise availability of all the systems, we could judge that we would not calculate core damage in any event, and we'll talk about that a little more when we walk through an example.

That's yet another reason why even though on its face they may appear to be sequences that would proceed to core damage, may not indeed go that far.

MR. PRATO: Slide 11, please.

MR. SHERRY: Okay. Now, we're at the Peach Bottom summary. Basically just two insights from the sequence selection process or that the total initiating event CDF is quite low, in the low to mid-ten to the minus six range, and we observed that the external event initiated sequences have estimated CDFs that are equal to or sometimes substantially greater than the internally initiated sequences.

MR. PRATO: Next Jason will talk about preliminary accident progress for the Peach Bottom.

MR. SCHAPEROW: This is just to set it up. This is what we get from our view of the PRAs. Again, as Rick said, no external event scenarios with the CDF greater than ten to the minus six, and the bypass scenario, the ISLOCA. At the PRA you had an extremely low number on that.

The only sequence we are left with is the longer station blackout for external events with a CDF of about ten to the minus six.

In the long-term station blackout, AC power fails both off site and on site diesels. We do have a HPCI left after this event. It is a turbine driven system, and its batteries are used to control the system, and so we have that system until battery depletion. So we do have injection for a while.

Of course, the question is what is "a while."

Again, batteries are needed to control injection, also to hold the relief valves open so they can start to depressurize. The battery life depends on the age of the batteries, how long they've been in the plan, and also the effectiveness of load shedding.

Peach Bottom does have a procedure to shed loads on their battery when they get into a situation like this.

The licensee gave us two numbers for their battery life in this all AC power failure situation. One estimate was two hours. That's based on when they would take the battery out of the plant and replace it. The battery is at that point.

The eight hour value that we got is based on a new battery recently installed in the plant.

Now, the issue of load share also is important. We understand that if the licensee did implement the load shed procedure as written effectively that they would be able to bring the two hour number up to something like four hours.

So, again, we're talking about several hours are available on the battery. Now, once the battery does go, we do have options for mitigation.

One option is the manual operation of a turbine driven system, in this case HPCI.

Also the licensee is purchasing equipment and implementing procedures to use portable generator and to inject with a portable pump, a portable diesel driven pump. This is recently purchased equipment or is going to be purchased shortly. So an initial look at this is that mitigation of rent core damage may be feasible for this sequence.

DR. APOSTOLAKIS: So what does that mean in terms of the actual calculation?

MR. SCHAPEROW: We have not yet begun the core calculations on this sequence. Just started. Excuse me.

DR. CORRADINI: We had a loss of on-site power.

MR. SCHAPEROW: We are just getting to the point where we are ready to start calculations with MELCOR for this season.

DR. MAYNARD: That really bothers me.

(Laughter.)

DR. APOSTOLAKIS: Well, Jason, you said may be feasible. What does that mean? Are you going to assume that these actually mitigation measures will be implemented?

MR. SCHAPEROW: The operation of HPCI, we will reflect that because we do have that. We'll have that until the batter deflates, and that will give us a certain amount of time until core damage, until things really start to go bad, and then we will need to take a look and evaluate how long for them to get the portable pump and generator in place to see, which is reasonable to model that also as part of the --

DR. APOSTOLAKIS: Is that part of any procedure that they have to do this?

MR. SCHAPEROW: They're developing procedures for this equipment. This is the new equipment.

DR. APOSTOLAKIS: And then what happens? If they are successful, when does core melt occur?

MR. SCHAPEROW: It won't. It doesn't.

DR. APOSTOLAKIS: You don't get any results.

MR. SCHAPEROW: The result may be a prediction of continued core cooling.

DR. APOSTOLAKIS: But ultimately you wanted to calculate deaths. It would be zero.

MR. SCHAPEROW: Well, the objective is to do a real estate consequence assessment. If there's no release, the consequence is zero.

DR. APOSTOLAKIS: But if you assume that these mitigation measures are successful, you're just cooling the core.

MR. SCHAPEROW: That may be a result of this scenario.

DR. APOSTOLAKIS: In which case the number of deaths is zero.

MR. SCHAPEROW: that's correct.

DR. APOSTOLAKIS: In which case then you would have to go to other sequences, wouldn't you?

DR. CORRADINI: Not unless they were directed to. That's what I heard earlier.

DR. APOSTOLAKIS: A political result.

MR. MONNINGER: No, no, it's not a political result. I think we are adhering to the program plan that we established. I mean, you know, the plan to carry out this study was proposed by the staff, endorsed by the Commission, and we are carrying that out.

DR. APOSTOLAKIS: I understand.

MR. MONNINGER: And we will report that. If there's other options or approaches they want us to take, you know, we would do that.

DR. APOSTOLAKIS: Yeah. There are two things that we are confusing here. One is that you are doing what the Commission directed you to do, which is fine. That's the way you should act. And the other is whether we are really doing what Bob mentioned at the beginning, namely, providing a bete estimate of the consequences, which you were not.

MR. MONNINGER: I think it's a best estimate of the consequences for the expected accidents for a realistic spectrum of accidents. You know, the notion of a project was not to calculate consequences for extreme events in the frequency range. It was meant to be if there was an event what is the more likely event and what are the bet estimated calculated consequences?

DR. ABDEL-KHALIK: Fundamentally do you think there is a fundamental difference between a cutoff frequency of ten to the minus six and ten to the minus seven?

MR. MONNINGER: Fundamentally?

DR. ABDEL-KHALIK: Right.

MR. MONNINGER: I mean in terms of what the results will be?

DR. ABDEL-KHALIK: No, no, in terms of a number that you pick out.

MR. MONNINGER: I think in terms of our confidence in our ability to predict events, I think there is a difference between events, you know, ten to the minus four, five, and six, and events that are ten to the minus eighth, ninth, tenth, eleventh, and twelfth. So I do think there is a difference between, you know, our ability to predict events in the more I don't want to say frequent range, but in the -

DR. ABDEL-KHALIK: But some of the internal events that you excluded were sort of in that fuzzy range, and the question is -- in my mind the whole purpose of doing this is, you know, to convey some information to the public, and anything you do that sort of casts doubt on the process by which you arrive at that final number will make the results of this study sort of DOA in a sense that nobody would believe it.

Because, you know, people may perceive it as biased, and if it is perceived as being biased, then it will not be believed and will not be of any value.

MR. ELTAWILA: But you will also have element of the public. You will have other groups that will look at the results and say, "If you don't have a containment failure, I'm not going to believe your results."

So you have to establish a criteria and

you try to do your analysis based on the criteria. And the staff has looked at the criteria and found that's a reasonable criteria because we have confidence in the way we calculate the frequency.

In addition to that, Charlie indicated that even for those scenarios that you are concerned about in the margin, they might not lead into core damage frequency. They might not lead into core damage, you know.

So the story is going to come together when you try to provide all this information together, but if you don't have established a criteria, we have one of our stakeholders say if you don't have any scenario that does not lead into immediate release, I'm not going to believe your results."

So I have to manufacture a scenario for him to accept that result. So you are going to get that regardless of what you're doing. You're going to get that criticism about the believability of the answer, and as long as we do the analysis and we do the uncertainty analysis, we do the best analysis that we can, and we try to justify it. I think that's the only thing we can do at this time.

DR. ABDEL-KHALIK: Now, would the uncertainty analysis include uncertainty in the cutoff frequency? I mean, would you go back and do this with a cutoff frequency of ten to the minus seven? If that is the case, you know, then that might add credibility to your bottom line result.

DR. CORRADINI: Can I ask? Are you going to answer his question? Otherwise I'm going to add to his question.

MR. SHERRY: Let me just answer. Remember this is an externally initiated sequence including a large seismic component. We want to assess the potential for using these special mitigative measures and equipment within the context at least for some fraction of that sequence frequency of a large seismic event having occurred.

And then we have to ask the question: is the portable pump available? Has it been damaged? Are the injection points that you're going to use to inject water into containment, are they available? Have they been damaged?

So you know, it's not like we're going to assess the mitigative action and the equipment in a vacuum without considering the context.

DR. APOSTOLAKIS: You will have a fragility curve for the bottom generator?

MR. SHERRY: No, we don't have that. I

don't even think that the plant has it.

DR. APOSTOLAKIS: So how can you ask the question whether it's available? I mean, this is a fairly strong effluent.

MR. SHERRY: Right. I mean, where is it stored? You know, is it stored in a seismic Category 1 building or in an industrial building? Questions like that.

DR. CORRADINI: But here's the sense of what I'm hearing at least. I don't know if I'm on the same page that he's worried about, but what I'm hearing is that if I knew what the CCDF curve is, you're saying that the shape of it has evolved because of licensee modifications, something from this to something like this with a tail down here that you don't know what it is and you're not going to find out from this study.

That leads me to then say, ut-oh. Then somebody is going to come back to you and say, "Where is that bottom?" You know, you've proven to me that it's like this instead of where it was like that, but you've chopped off the frequency, and I ask you where it is and you say, "Well, we weren't asked to find that."

Can you imagine the push-back you're going to get from some quarters?

I mean, that's what I hear from the discussion here, is that you really are saying that you've by conscious effort of proper engineering pushed the whole thing to be more reliable and lower consequence, and you don't know if there is a bottom out here, nor do you know where it is. You don't know where it is this way. You don't know where it is that way.

CHAIRMAN SHACK: But again, coming back, you know, there's a question of whether you're looking at risk or you're looking at consequence. If you're looking at consequence, I think the choice of a cutoff frequency is a policy decision. You just have to sort of decide what's a reasonable number to pick.

The uncertainties would come in to make sure that you got every sequence that really had that. I don't think there's such a thing as an uncertainty in the threshold number. There's an uncertainty in whether a sequence meets that threshold number, but it seems to me the threshold number is a policy decision, and you know, you make that. It's like any policy decision. You know, it's hard to say whether it's right or it's wrong. It's a decision, and you know, these are the consequences with this kind of a cutoff.

It's a different answer that you would get from a risk analysis where you looked at everything and counted in the likelihood that it would happen. You're asking two different questions.

DR. CORRADINI: So is the way to ask Said's question because it's appeal to me is instead of changing the limit based on a certainty is to ask what's the uncertainty in the number we were given a few slides back?

CHAIRMAN SHACK: And you know, is there another sequence that the uncertainty would push up into the range that you were looking at? And I think the answer seems to be no, and the consequences of all those sequences are bounded by the sequence that he has picked.

But, again, to argue that you should really be doing a risk study when they are doing a consequence analysis, you know, that's a different decision than you're now doing a consequence analysis. The cutoff frequency is a policy decision, and what you have to do within the context of that analysis is to make sure that you're consistent with those assumptions, and I think, you know, they're trying to do that.

DR. APOSTOLAKIS: Yeah, but the objectives were not stated that way. Determine best estimates of the radiological consequences. It didn't say according to a certain policy.

CHAIRMAN SHACK: But I think with a consequence analysis you always have to make that statement, that there is some -- you know, the risk may reach some asymptotic level, but the consequences -- well, they're probably reach some asymptotic level, too, but that asymptotic level could be --

DR. KRESS: You've got to avoid having another NUREG 740.

CHAIRMAN SHACK: Right. You know, NUREG 740 is probably the asymptotic limit.

DR. KRESS: Yeah.

DR. ABDEL-KHALIK: But in the eyes of the public the concern is the low frequency, high consequence event. So if you arbitrarily draw a bottom line on the frequency, you will not satisfy a lot of people.

CHAIRMAN SHACK: You can't satisfy everybody. I think a rigorous analysis to the threshold frequency that they've done gives you a picture, you know, whether it --

DR. APOSTOLAKIS: It doesn't give me the best estimate I was promised.

MR. MONNINGER: I think in just one statement here with regard to our goal, I do think it is consistent with our goal because if you keep reading on it talks about off site consequences for dominant accident sequences, and what we're doing here is we are calculating to consequences for the dominant accident sequences.

CHAIRMAN SHACK: Except the definition of dominant is a decision that you make.

DR. APOSTOLAKIS: Right. For dominant accident sequences, for accident sequences dominate in the core damage frequency. That's what it should be.

CHAIRMAN SHACK: Accident sequences for the release frequency greater than ten to the minus six, which they are approximating by going back and looking at core damage frequencies of ten to the minus six because they think that's a conservative estimate for the release frequency.

MR. TINKLER: Yes, and we are further going down --

DR. APOSTOLAKIS: You are --

MR. TINKLER: -- that day for the bypass.

DR. CORRADINI: I understand that, but, Charlie, here's where I'm still struggling. So we say to you, okay, you've neglected those three, and you say, well, those are qualitatively similar to the one we're including. Okay. Now we have a sequence for all of Peach Bottom that kind of looks, smells, walks like a duck, quacks like a duck, looks like all of the other ones that you've left off because they're a little bit lower frequency. So it could generate the same qualitative source term.

Now you put in very perfect operation of mitigative effects. That gives me real pause because now --

MR. TINKLER: Well, let's talk about this.

DR. CORRADINI: Wait a minute.

MR. TINKLER: Rick mentioned that, look, we know that we've identified this for a seismic event, and there are questions about whether or not this mitigation capability would be functional during a seismic event.

DR. CORRADINI: So if I went down --

MR. TINKLER: I just want to say that's not a done deal on this one. You still need to look at that issue, and at the end of the day, at the end of the day it might turn out that we do a calculation where the mitigation is effective and the mitigation is not effective. It's not in concrete, but that might be how it turns out.

So if you want to assess how reliable that additional mitigation capability will be and how important it is --

DR. CORRADINI: You look at the two extremes.

MR. TINKLER: -- you look at the two calculations.

DR. CORRADINI: So then the second part of my question goes like this. So now you have Peach Bottom. You have a site; you have a location. You go back to the '82 study. What did the '82 study show for this site relative to what you -- so in other words, if I were going to do this from a best estimate standpoint, I kind of look back 25 years and say, "Gee, what did this site look like then relative to it, compared to now?"

MR. TINKLER: Well, let's talk about that. This is going to generate a source term of a given timing, and one could pretty clearly in the worst case -- assuming the mitigation does not work, we can compare that source term both qualitatively and quantitatively to the SST-1 source term and see that they are manifestly different.

DR. CORRADINI: The SST-1 --

MR. TINKLER: Yes, the SST-1 is a source

term --

DR. CORRADINI: -- is the big source term that made --

MR. TINKLER: That came out in an hour and a half. Okay? Over half the core radionuclide inventory in an hour and a half. This one, radionuclide, even if nothing works beyond what we described here, you'll be looking at a release in 16 hours, 18 hours, 20 hours. So your whole concept of the effectiveness of EP and everything changes radically just by looking at that. Okay?

DR. CORRADINI: Okay, but to me that would be a useful -- if you say that it's on, you know, the mitigative works, doesn't work, now you've got the extremes. No discussion about what the shape looks like. That gets me personally nervous.

It's on; it's not on. And then you look at historically. Then you have a way of kind of balancing what you've done relative to what occurred 25 years ago.

MR. TINKLER: Agreed, although like I say, I'm not sure how we proceed to one with and one without, whether or not we develop, God help us, a distribution before that with and without, but you know, there are other ways to address that issue to look at the importance of those measures, what kind of reliability you would like to have for those measures, but ultimately if we get to -- if we were identifying sequences where we thought the additional mitigation was effective and was reliable, then we would have no sequences.

This is a special case because it's a seismic event. Okay? If it were an internal event, we would think that the additional capability that's been brought to bear in the plant could very well be effective. We wouldn't have the same kinds of concerns, but because this one has a special set of conditions attached to it, we may have to look at it a little more.

CHAIRMAN SHACK: I mean, we won't ask you how you're dealing with security issues because that kind of throws these frequencies out the window.

MR. TINKLER: Agreed, but it's important to recognize that what we're actually ending up with is I won't say a routine, but you know, a long term station blackout is not some sequence that's never been considered. And the fact that we're ending up with a long term station blackout that has a signature associated with it is quite different than what the 1982 study has.

CHAIRMAN SHACK: Another question is why Peach Bottom didn't find this in their internal events IPE. Is that because they had a ten to the minus five cutoff for vulnerabilities there and you're going to ten to the minus six here?

MR. SHERRY: Well, this is external events.

CHAIRMAN SHACK: No, IPEEE, their external events thing. They presumably did it, and they didn't identify this as a vulnerability then. Did they do a lousy job on the external events?

MR. SHERRY: Well, I think with frequencies at this range, doing an analysis may not result in identifying the vulnerability.

CHAIRMAN SHACK: Right. I mean, they wouldn't have called it a vulnerability. It's so low that it's still not a vulnerability from that point of view. I mean you've now pushed it down.

MR. TINKLER: I think it's pretty clear that these kinds of results are consistent with license renewal PSAs. There's nothing shocking about that from that standpoint, that the external events are larger frequency than the internal events in the license renewal applications that have been seen, correct?

DR. APOSTOLAKIS: License renewal PSAs? Does anybody do that? Who?

CHAIRMAN SHACK: Everybody.

DR. APOSTOLAKIS: They just look at the difference in the human actions?

CHAIRMAN SHACK: No, no, no. This is license renewal, not power uprate.

MR. TINKLER: This is not an atypical result.

DR. KRESS: It's going to be a lot more typical for the new plants.

MR. TINKLER: It's starting to look like a new plant. CDF would look with the additional capability and a harder look at some of these things. They're starting to look like -- the internal event CDFs are starting to look not quite as well, but they're --

DR. APOSTOLAKIS: What would be the additional level of effort to actually do a Level 3 PRA?

MR. TINKLER: I knew this was coming.

DR. APOSTOLAKIS: No, I mean, are --

MR. TINKLER: It's logical.

DR. APOSTOLAKIS: -- we talking about something huge?

MR. MONNINGER: Order of magnitude. Order of magnitude, George.

PARTICIPANTS: An order of magnitude.

(Laughter.)

MR. MONNINGER: I think, you know, to myself when I think about this project, the way I put it into context is, you know, over the past ten to 15 years, you know, essentially what the NRC has done is focused on core damage frequency. I mean, the reactor oversight process, SDP, et cetera. I mean, we do a little bit of LERF, but we don't do full blown, you know, Level 2 or Level 3, and we have our surrogates there, and you know that through past studies the surrogates show that if your numbers are less than this, you generally met the safety goals.

And through that we have learned a lot with regard to the safety of the plants. One of the things we also want to do with this project is show what the other tools we have out there can do in terms of demonstrating the safety. So as opposed to, you know, in the past we're spending 95 percent of our time on CDF and Level 1 on the front end and very little on the back end, the focus of this project is really supposed to be on the back end, on the MELCOR analysis and the MAX analysis.

I mean, we have put in a considerable amount of time on the sequence selection and all, but one of the things we're trying to demonstrate from this project is the enhanced safety in these designs when you do do the severe accident progression, accident analysis, et cetera.

So in terms of our resources, we really want to devote our resources to that back end and not, you know, what we've done over the past 15 years to the front end. So I'm not sure if that helps at all. You know, where we have been the past 15 years and at the same time advances have occurred with system mods and availability and reliability. The same has occurred on the back end, and it's time to look at that back end, and that's what we're trying to do.

DR. ARMIJO: But if you cut off the CDF at too low a value or high a value, you don't exercise all and see the benefits of all of these other improvements on the down stream. That's why I asked the question. If you hadn't had an external event as far as Peach Bottom, that would be the end of the analysis, right? Nothing happened.

MR. MONNINGER: It would have been for where the criteria were set, yes.

DR. ARMIJO: I would have said, well,

invent something so that you do find out what happens if you challenge a containment or leak and you get all of the plume effects you know about.

MR. MONNINGER: And let's say, for example, we did that or, you know, some plants had cutoff values here and others were there. If ultimately, hypothetically, if ultimately there's a table out there that lists this, I mean, what kind of comparison would that provide of these relative plans?

If, for example, some pass the screening criteria and you used events, others were lower but you hypothesized some event in there. I mean, what kind of portrayal of results would that provide?

DR. ARMIJO: It's sort of like a defense in depth. It says even if that failed, these other improvements that we've made in meteorology or evacuation planning, all of these, you're going to be protected by virtue of these other downstream --

MR. MONNINGER: I mean, you know, if we would have done that, I mean, we could have just hypothesized some event and applied that event to every single plant out there, you know, as opposed to really trying to go in plant by plant and identify the sequence.

We may go if we continue this study to the next BWR, you know, three or four, slash mark, one. It may be a different sequence. It may be an internal event, you know. So we're trying to do it as site specific as possible, and if it ends up that they're below the mark, they're below the mark or above. I'm not sure.

MR. TINKLER: Once upon a time we were asked, well, why don't you just redo the SST-1 with all of your better technology. Well, that kind of ties both hands and both feet behind your back, but we could do better plume dispersal, I suppose, but you know, it would be kind of -- so we have to decide how far you want to go on that.

So we think the most important thing is to demonstrate when it shows itself that these sequences at a minimal have much more relaxed, if you will, timing associated with them. You know, you can't melt 100 tons of fuel in an hour and release the fusion products in the next ten minutes. These kinds of events take longer to evolve. The thermal hydraulic calculations reveal that.

The thermal hydraulic calculations also reveal that the opportunities for mitigation are more than you thought in the past and that it's easier to mitigate than might have been thought in the past, and that you can recover events later than you could in the past, a la TMI.

So you know, all of those points we would want to show, but we don't want to create an artifact in order to show those either. We don't want to elevate artificially the importance of a sequence.

DR. APOSTOLAKIS: So if I go to 1150 and I look at the Peach Bottom seismic contribution, how much does it contribute to deaths? And how different is your new result from that? That would be an interesting comparison, and that would be meaningful, in fact, because you're comparing apples to apples.

MR. TINKLER: Yes.

DR. APOSTOLAKIS: I mean, if you don't remember, you don't remember.

MR. TINKLER: No, no, no.

DR. APOSTOLAKIS: I mean, what is it that they didn't have at the time? These options for mitigation?

MR. TINKLER: Well, they clearly didn't have, you know, all of the more recent mitigation options, this new portable pump, this new portable generator.

DR. APOSTOLAKIS: Right.

MR. TINKLER: You know, all of the efforts to more effectively use diesel driven systems, you know, not to mention CMGs that have been developed since that time, the guide operators. There are a host of additional things that could be brought to bear that would in some cases lower the frequency and in some cases vacate it, okay, at a minimum increase the timing.

DR. APOSTOLAKIS: There would be two answers or two questions to which the answers would be useful. One, how much are the early deaths affected by the mere fact that we have better computational tools now?

And second, by how much are they affected by the additional mitigation? And then, of course, the combination.

MR. TINKLER: Right.

DR. APOSTOLAKIS: Because when 1150 goes down, there was a comparison with WASH-1400, and they found that in terms of release of cesium, the median of 1150 was about an order of magnitude lower than the median in the WASH-1400 evaluation, and that was attributed primarily to better models, removal of conservatisms.

That's an interesting insight. The difference between the two studies was something like

12 years on average maybe, maybe 13 years or something like that. So in a period of a little over 13 years, the models improved and the impact was an order of magnitude down.

I mean these kinds of comparisons make sense and also you have these mitigation measures and so on. It would be nice to see the impact.

MR. TINKLER: Well, to the extent that Rick's earlier table reveals how internal event frequencies have dropped, they've dropped primarily as a result of the additional systems. Okay?

To the extent that when you eventually get to a scenario where the core melts, you would see the reduction and we will see that if we do a calculation that proceeds. We'll see a further reduction in the cesium release fraction, and we'll see a delay in the timing of the release, and coupled with more realistic treatment of EP, it will cascade to reduced health effects.

DR. APOSTOLAKIS: Okay. So, I mean, it would really be nice to see how these curves that are shown in 1150 move as a result of these things. That's a useful contribution because the curves have been produced, and I'm sure they move towards the lower left-hand corner there, right, to be consistent with the consequences?

These are very useful results in my view.

MR. SHERRY: I just want to add one thing to what Charlie said. I think another major reason for the drop in core damage frequency is essentially industry performance in terms of the reduction in component failure rates and initiating event frequency. That has had a substantial impact on --

DR. APOSTOLAKIS: And common cause failures.

MR. SHERRY: And possibly common cause failures.

DR. APOSTOLAKIS: Not possibly. We've seen evidence of that.

MR. SHERRY: Okay.

DR. APOSTOLAKIS: They keep going down.

MR. SCHAPEROW: Okay. Can we go to Slide 15, please?

DR. APOSTOLAKIS: Is that a slide?

PARTICIPANT: We lost power.

MR. SCHAPEROW: Paper copies.

(Pause in proceedings.)

MR. SCHAPEROW: As Rick had mentioned, we did initially have an interesting scenario identified for Peach Bottom and an internal event scenario, and we did do a little bit of MELCOR analysis on this scenario. I just wanted to talk about what we learned just briefly.

The scenario is the loss of vital AC bus E-12. This scenario involves the loss of AC power to the DC inverters. We do have some systems still operational for this sequence. We have turbo driven systems, control high drive hydraulic system which has two pumps. We can open and close SRVs, and we have low pressure injection.

The EOPs in this case will direct the operators to maintain level with RCIC turbine driven system and begin a controlled depressurization, and again, where we lost our DC inverters, now we just have the battery.

We did perform some preliminary analysis in MELCOR. I'd like to direct you to Slide 16 to show the results.

DR. APOSTOLAKIS: Let me have the slide. The first line, E, dash, 12.

MR. SCHAPEROW: That's the name of the bus.

DR. APOSTOLAKIS: It's not E to the minus.

MR. SCHAPEROW: No. I know it looks like it.

(Laughter.)

DR. APOSTOLAKIS: I was hoping for a second.

MR. SCHAPEROW: The name of the bus is E-12, and this particular bus is an important one because it's the one that provides power.

DR. APOSTOLAKIS: So what is the frequency of this sequence?

MR. SCHAPEROW: Originally we were right about at ten to the minus six, but now we're down about a factor of ten.

MR. MONNINGER: I think one thing important to recognize is, you know, over the past couple of months the staff, we were running with this as a potential internal events sequence. We then met with the licensee in an effort to insure that we were modeling and representing the plan as realistically as possible, and it ends up that there were some differences in assumptions between, you know, the plant and the way the NRC was modeling it, and it eventually screened out.

So you know, we are trying to stay religious to the project in terms of what the screening threshold was. One day of the week, one --

DR. APOSTOLAKIS: The ten to the minus six cutoff came from the Commission

DR. ARMIJO: Initial Commission study

DR. APOSTOLAKIS: It's in an SRM that you have to consider sequences only of frequency greater than ten to the minus --

MR. PRATO: On initial focus.

DR. APOSTOLAKIS: That's what the Commission said.

MR. PRATO: That's what they told us.

DR. APOSTOLAKIS: When did they say this?

MR. PRATO: Actually --

DR. APOSTOLAKIS: The date is? April 14, 2006. So initial focus means? How long is initial?

DR. CORRADINI: Until they tell us something different, I'm sure.

MR. PRATO: Until they give us different directions.

DR. APOSTOLAKIS: Oh, they have to tell you something. I see. Well, maybe we can help them do that.

MR. SCHAPEROW: I wanted to just spend a minute on this because it did illustrate one of the things that we are coming across in these kinds of scenarios, which is we do a realistic analysis of MELCOR, and we come up with either known core damage or core damage. In this case I would say no core damage.

If you take a look at Slide 16, the bottom curve shows the reactor vessel water level with no injection. It just keeps going down as a result of boiling off through the SRV.

But a realistic look at this, we have a RCIC operation for probably quite a number of hours actually. We just assumed RCIC operation, operation in one case for two hours, in another case for three hours.

What that does is that provides injection of the vessel for a few hours, at which point the decay power is now a lot lower. This sequence also has one controller drive hydraulic system pump operating. So that is enough to get you to the point where you don't get core damage after many hours because that 110 gallon per minute from the controller hydraulic system is enough to overcome decay power after a few hours.

DR. CORRADINI: That's the light gray one that sits there and hovers at nine feet.

MR. SCHAPEROW: Yes, that's it.

CHAIRMAN SHACK: So the battery lets you hang in there long enough so that you can then cover your butt with the CRD drive.

MR. SCHAPEROW: Exactly, exactly.

DR. CORRADINI: And how are you covering your butt with the CRD hydraulic? How is that water coming in after you get rid of your battery power?

MR. SCHAPEROW: It's an AC driven system. In this case we lost --

DR. CORRADINI: In a different bus.

MR. SCHAPEROW: In a different bus. That's right. We only lost one bus. We still have the other three.

DR. CORRADINI: Got it.

MR. SCHAPEROW: So anyway, so the message here is that if you do detailed thermal hydraulic analysis, you can see some margins to core damage, and in this case again for three hours of RCIC operation plus one CRD pump is no core damage.

So we didn't get a release for this scenario.

CHAIRMAN SHACK: The model uncertainties in MELCOR are small enough that I believe these numbers.

MR. SCHAPEROW: I think this is basically a question of decay power. We were able to keep up with the boil off with enough flow. I don't know if this is even a MELCOR specific --

MR. TINKLER: Well, the top curve, we're both core and mid-plane. There's no reason to believe there's any significant uncertainty in that calculation

CHAIRMAN SHACK: That's true. I mean, as long as we're sort of dealing with heat and mass balance.

MR. TINKLER: The top curve looks like by our standards pretty impact geometry.

MR. SCHAPEROW: Yeah, the two-hour curve, two hours of RCIC operation would correspond to the absolute worst case where you had old batteries, no load shedding. That was the absolute quickest case, and even that one we didn't see much core damage. The water level dropped down to around a little below vessel core mid-plane.

Actually it's notable for this sequence. There was actually other mitigation that could be brought to bear. There's a procedure for increasing CRD flow by by open ended throttle.

Oh, 15. Sorry. Still on 15.

DR. APOSTOLAKIS: So which curve are you looking at? This is the only time we are really with this.

MR. SCHAPEROW: I'm sorry. There's one bottom curve, no injection. The top three curves have RCIC operation for either two or three hours plus CR&D.

DR. APOSTOLAKIS: Okay. There are two light grays or one dark gray and one light gray.

DR. CORRADINI: The one in there that comes down is the CRDHS one. That one.

DR. APOSTOLAKIS: Okay.

CHAIRMAN SHACK: But you have no calculations yet for the external event sequence.

MR. SCHAPEROW: That's correct. We're just starting those now. Bob said we just got the information from the plant. Whatever additional information so it will beef up tomorrow for the last week or two, and we're just going through that and making --

CHAIRMAN SHACK: But you're going to do that calculation without the new fire driven pump or the new fire pump thing and with?

MR. SCHAPEROW: We may do it both ways.

DR. CORRADINI: We got a "may" out of them earlier in the discussion.

MR. SCHAPEROW: Yes. We were thinking about that for a while. That is just an issue we're wrestling with.

Let's go to Slide 17.

Overall insights from the Peach Bottom work so far. Two scenarios that we looked at that were initially identified involved loss of AC power; warning of loss of AC power throughout the plan. The other one was just the key equipment.

As Charlie noted, these scenarios evolved slowly. If you have eight hours of battery life, which you might have if you do some load shedding, it will be eight hours until you even start to lower the vessel level.

And then after that you're going to have many more hours because you're out far enough in the heat curve. It's going to take a while to boil stuff off, and you've got maybe 20 hours before core damage and vessel failure in such a case.

Our initial evaluation so far shows that the PRA success criteria do appear conservative certainly with respect to effectiveness of CRD hydraulic system. We feel that best estimate calculations would likely demonstrate no core damage for this type of scenario.

DR. APOSTOLAKIS: This is an internal events scenario.

MR. SCHAPEROW: For that one, yes. We don't think we'd see core damage if we continued these calculations.

DR. APOSTOLAKIS: So these insights are really very useful, aren't they?

MR. SCHAPEROW: We think so.

DR. APOSTOLAKIS: You would not have derived them if you had applied your cutoff frequency.

(Laughter.)

PARTICIPANT: You were done for when you said that.

MR. SCHAPEROW: Well, I think it is a more general --

DR. APOSTOLAKIS: I like them. I think they're great.

MR. SCHAPEROW: When you're doing a risk --

DR. APOSTOLAKIS: You wouldn't have given yourself a chance to produce them.

MR. SCHAPEROW: When you're doing a risk study, you have lots and lots of scenarios and lots --

DR. APOSTOLAKIS: Keep going.

MR. SCHAPEROW: And the idea is that when you take the time to do an analysis with a code such as MELCOR, you're going to identify areas which may have been treated conservatively in the past, and we have to do a better job.

DR. APOSTOLAKIS: You're right, absolutely right, and all I'm saying is you should give yourself opportunities to do this. This is great.

MR. SCHAPEROW: Okay.

DR. APOSTOLAKIS: I'm trying to agree with those guys and they refuse.

By the way, I hope you understand that all of these comments are made in order to be constructive. Okay? I'm trying to be constructive and they fail every now and then.

(Laughter.)

CHAIRMAN SHACK: We're from the ACRS, and we're here to help you.

(Laughter.)

MR. PRATO: Are there any more questions on the board? Oh, you have got one more?

MR. SCHAPEROW: Yeah, one more. The last bullet which deals with manual intervention. You know, these are slowly evolving scenarios. So it looks like there's going to be enough time to do a lot of manual intervention, and so they could prevent or limit the extent of core damage.

DR. APOSTOLAKIS: Would you say that this is a fairly general conclusion, that in the past we have been conservative and we have overestimated the speed with which things evolve, the pace at which they evolve? I know this is the result of this one, but is that a more general result do you think?

MR. SCHAPEROW: I think so. I think that's the nature of the research. As time goes on you develop better modeling and you're able to eliminate conservatisms as you go along.

DR. CORRADINI: But I mean there is some physical modeling effects that you mentioned, somebody mentioned somewhere in the earlier bullets. I mean, the one that pops in my head is by the very fact you've observed that you've held the melt within the core region, you actually cook away many of the things that actually could provide you even more heating.

So now you've changed the potential heat-up or integrated amount of heat release so that you've now dragged out even the whole end core sequence. Add that to the fact that you now have potential small flows of water that then once you've dragged it out and decay heat is down even further, you can inject them. Now you've dragged even further.

I think that was where George is going. There's a combination of things that create the sequence to be really dragged out.

MR. SCHAPEROW: The reason the decay heat would be down is because they have basically been making up for decay power with the turbine driven pulse for a while, and so after eight hours now you don't need as many gpm to make up for the boil-off. Is that what you were referring to?

DR. CORRADINI: Yeah, that and also you had a couple bullets about MELCOR modeling which identified now some physical effects from experiments that then put back into the integrated model. So now that you saw in the experiment and you've included in the calculation, now you're seeing an effect of essentially dragging out the whole meltdown process. That's what at least I --

MR. SCHAPEROW: What I was trying to say earlier is that we were trying to treat in more detail what's going on inside the core region. It may hold things up maybe a little longer in the core region, but things may happen a bit faster in the lower climes. So that may all kind of wash out. It's hard to see how it's going to play out yet

DR. ARMIJO: I'd like to ask a question on the batteries. If you have an external event, how confident are you that those batteries aren't damaged so that you can get all of the energy out of them? Do they have a lot of --

MR. SCHAPEROW: There are external events that are severe enough to -- I may not be the best person to answer that. Rick, can you help me with that?

MR. SHERRY: I think probably we should ask our seismic expert. Selim.

DR. ARMIJO: I don't know anything about batteries. Is there a lot of margin that a battery set has compared to other equipment during an external event?

MR. SANCAKTAR: Selim Sancaktar, NRC.

There is another sister sequence to this with a slightly lower frequency, and in that case there is earlier core damage potentially. So batteries can also be damaged.

DR. ARMIJO: Okay, but this particular sequence, a seismic event wasn't sufficient to damage the batteries in any way? You get 100 percent of the energy out of those batteries?

MR. SANCAKTAR: Right, right. Remember these are representative sequences. One can find almost n-factorial combinations of failures. What we have tried to do was choose something consequential enough to capture the essence of the situation, yet don't overdo it or under do it. So it requires a little bit of expertise and judgment.

But there is a second sequence here that you haven't seen because its frequency was lower than this artificially chosen ten to the minus six. So you don't see it, but there was a sequence like that.

DR. ARMIJO: That event damaged the batteries to some extent.

MR. SANCAKTAR: Yes, yes.

DR. ARMIJO: Okay.

DR. MAYNARD: batteries in a power plant are pretty substantial, you know, not all that dissimilar from a battery in a car. Typically they can take a pretty good shock and stuff. when you're talking about external events and seismic, I mean, you can always get an event that you want to postulate that would destroy everything, but a battery is typically going to be a fairly substantial item in something like this.

MR. SANCAKTAR: It doesn't have to be just the batteries, of course. It can be the cabinets that eventually you feed. That is probably more likely than the battery. As you mentioned, batteries are probably more robust.

DR. MAYNARD: But these are all seismically qualified, but you're obviously talking about a seismic event that exceeds the safe shutdown requirement.

MR. SCHAPEROW: Okay. That ends the preliminary insights on Peach Bottom. If we can proceed to slide 24. Ata Istar is going to give you a presentation on the structural analysis.

MR. ISTAR: Good afternoon. Just the Peach Bottom section, right?

The objective of the deterministic structural analysis here for both Peach Bottom and Surry was done, and the performance structure evaluation of each containment at selected site to determine functional failure pressure leading, structural failure pressure rupture, and the real objective of the structural evaluation is to determine realistic, plan specific leakage rate and/or area as a function of pressure that can be used as input data for MELCOR analysis.

Next page, please.

For Peach Bottom, considerable variations in predictive failure pressure levels and locations in numerous studies were performance previously. Failure pressure varies between 86 to 195 psig at various temperature levels, and those locations are drywell shell melt-through, wet well rupture, equipment hatch leakage, bellow failures, penetration failures, seismic stabilizer punch-through of drywell shell, and drywell head flange leakage.

Next page, please.

And as an approach, reviewed, reevaluated major failure criteria based on the 25 years of research and testing carried out at SNL and other reports.

And based on those results, the plant specific information, the most dominant cause for leakage is determined to be at drywell head flange.

And next page, please.

This is the --

DR. CORRADINI: This is not due to the external event. This is due to the pressurization.

MR. ISTAR: Internal pressurization, correct.

DR. CORRADINI: Okay. Thank you.

MR. ISTAR: And this is the elevation view of a drywell head flange assembly. There are 68 two and a half inch bolts around those flanges, and the next page gives you the detail of that flange connection.

CHAIRMAN SHACK: I mean, did you do analysis for of these other failure modes at Peach Bottom?

MR. ISTAR: Not all of them, but reviewed each one whether they're credible and our intention is to find the realistic low pressure level that can be different than what has been done in the past. This is the evaluation that is somewhat lower than what was reported in the past.

And the next page which shows the detail of that flange connection, and it is a double prong connection which EPDM gaskets in there, but there are some unknowns in there, which is the pressure retaining ability of the gasket, and there is quite a bit of discussion, one, with the manufacturers, and it's, yo uk now, expected in our analysis here. It's recovery of gaskets, about ten percent from its original shape after it's compressed, of course.

And one of the manufacturers' engineers gave a value of about 15 percent. I assume that is a high value from the manufacturer's point, and also they recommended in the static condition like that that the gasket is not to be compressed more than 30 percent.

In the Peach Bottom case, it is kind of

compressed about 50 percent, and also there are other reports that indicate -- the post test inspections that indicate that all gaskets experience severe degradations. In this calculation, it's the kind of gaskets -- the pressure retaining abilities are going to be considered very limited, very, very limited.

On the next page --

DR. ABDEL-KHALIK: So this scenario here involves elongation of all these two and a half inch bolts?

MR. ISTAR: Correct.

DR. ABDEL-KHALIK: And that's why the gasket sort of leaks out?

MR. ISTAR: Correct. And the next pages shows that by the table and the graph, and that table is much longer than what it is. I had to cut out that table, and as the pressure builds up and the bolts are elongated and somewhere on 80 psig we have a crack open and start leaking, and the graph was presented here to show that pressure versus area of the leakage area. So that's for the Peach Bottom.

So this value, 80 psig, is kind of lower than what was reported in the past. So we believe --

DR. CORRADINI: What was reported in the past?

MR. ISTAR: Eighty psig is lower than what was reported. It was like I think the lowest reported as 86 psig or something.

CHAIRMAN SHACK: That's what your slide says.

MR. ISTAR: Yes. But, you know, there are others. IP, for example, there are conditions. This particular calculation doesn't involve temperature. It's ambient temperature. For example, in IP there is a condition which has a temperature range of 1,200 degree Fahrenheit and the whole containment fails at lower pressure, which is about 48 psig.

But you have to put it into context that this is -- I'm assuming that we are in the ambient temperature and this will be the worst case and you don't have a high temperature condition, you know, and the pressure is the dominant failure mechanism.

DR. CORRADINI: So just to make sure I understood what you just said, this was done cold, not at the accident temperatures?

MR. ISTAR: This is done at cold.

CHAIRMAN SHACK: And why is that relevant? Why would you do it cold?

MR. ISTAR: Why would I do it cold? Because it's easier to do the analysis.

CHAIRMAN SHACK: Oh, okay.

MR. ISTAR: That's one reason, which this is an Excel calculation analysis, much easier, and there is an argument. I kind of skipped that one. This is important to note that. The bolts were torqued to 850 foot-pound, and it is extremely low torque value for this bolt. Just putting it into context, it is probably less than 15 percent yield of that bolt. It's very, very low, and so I'll just state it's a snug tight condition here, but in the other reports, which they came up with a much higher pressure lever for leakage, which is around 120 psig, but they use a very, very high torque value.

So this is specific to this plant, you know, based on the torque value, but going back to your questions of temperature, there are reports that they've done that they say there's a difference between the temperature at the bolt and the drywell flange area or the containment shell, and the argument is that since you have a colder bolt, have delayed action, you know, flowing temperature, conducting temperature through the bolts, and they have a more holding ability than in this particular calculation we assume that temperature is, you know, the same throughout the body of the whole containment.

So intuitively it makes sense, but in this particular calculation we assume that the temperature will conduct very fast, and it will include equilibrium in a very short period of time.

You know, if you were to consider that the leakage probably is going to be at a lower pressure rate, so module elasticity of the bolts will be, of course, lower and they're going to -- you know, resistance of those bolts is going to be going down.

DR. CORRADINI: Okay.

MR. PRATO: All right. That ends the presentation on structural for Peach Bottom. Emergency preparedness, Slide 42, please.

MR. JONES: We introduced this this morning. Basically the preliminary model for Peach Bottom is developed. We can't populate it fully until we have our source term values, but it's based on long-term station blackout scenario where a general emergency is declared in about two hours after loss of AC.

Evacuation does start at general emergency for this scenario.

Slide 44.

We're modeling the evacuation within the emergency planning zone. That's the zero to ten mile zone, using the licensee evacuation time estimate report. For this site we're basically calling that estimate good and taking that as gospel and using those values.

From that report we get our delay time, such as when does the school cohort start or when does the public start. Those are our delay times, and then we also get the speed of the evacuating cohorts.

Now, the second part of our EP modeling is we recognize that from ten to 20 miles there will be movement of the public as well. So Sandia is modeling the ten to 25 mile ring using the Oak Ridge evacuation model or OREMs, and we're doing just a crude model. You'll see some of the nodal networks. It's not that crude, but you'll see that in a couple of slides demonstrate the amount of detail we're putting into there.

From our model we will then be able to decimate the delay times for this evacuation, and we call it ad hoc in here because keep in mind that the ten to 20 mile zone is not planned to be evacuated at this point under most conditions. It's not planned under any conditions.

And then we use that model to estimate the travel speed.

Page 45.

We've identified six cohorts that I'll list again in a couple of slides, but I mentioned them earlier today.

Now, for Peach Bottom early precautionary actions at site area emergency are not taken in Pennsylvania, and that's not typical. In most of the evacuation emergency planning that we've looked at and reviewed schools at the very least are evacuated at site area emergency, but that wasn't the case for this.

Peach Bottom does border Maryland, and Maryland follows the Pennsylvania lead. Sow e are assuming they would not have preliminary actions at site area emergency either.

Page 46 is put in here to illustrate a concept of how we're developing our data. So please don't, you know, put any value into these numbers at this point. I tried to change most of these to variables.

But what you can see here is you have an unusual event, which is immediately followed by an alert and then site area emergency. Once the siren is initiated, there will be a shadow evacuation, and we just see this with all of the evacuations we studied.

So we --

CHAIRMAN SHACK: Which means? Shadow?

MR. JONES: A shadow evacuation is people that have not been ordered to evacuate but are evacuating. So it's a real phenomenon and it happens.

We're going to start a shadow evacuation, which is one of our cohorts. At general emergency, that's where the formal evacuation would begin and for Peach Bottom that's where schools would start to be evacuated, special facilities.

Now, here underneath that I have a shadow and special facilities. That special facilities really should be moved to the right, but when there's a formal evacuation of the zero to ten, we fully expect a shadow evacuation in the ten to 20. So we're going to move that cohort group. And we'll have to develop times all of which will have a basis associated with them when we put that together.

And then you can also see and hear after the general emergency you have a public evacuation, and then you have the tail that I mentioned earlier. We want to track that last piece of the evacuation separately.

At some point after release, at the bottom of this page to the far right you see public and schools and another evacuation tail. This is for the people in the ten to 20 mile zone. That's dependent on what the source term tells us. That may or may not exist. If the source term indicates that there's a dose far enough that an evacuation would be warranted, it would include them. If it is not warranted, we would not include them. So we'll have to wait until we get our source term.

DR. ARMIJO: Now, the early shadow evacuation, how do these people know? Just from the siren?

MR. JONES: Just from the siren. These are residents within the zero to ten miles. So they would likely be ordered to evacuate anyway, but they just take off.

The siren doesn't always mean evacuate, and in this case it wouldn't mean evacuate. It means --

DR. MAYNARD: Well, there's a radio frequency that the people could tune to also to get emergency notification.

MR. JONES: Correct. It's a siren or if there is speaker systems at Peach Bottom, that would tell them tune into radio or TV and wait for further notification.

And in this particular instance both the long-term station blackout, general emergency wouldn't have been declared yet so that evacuation would not have been ordered, but we would expect people to get in their cars and start leaving, and that is very common.

Page 47 just gives you an example of how this is starting to look. Our zero to ten miles, we have about 70,000 people, and in the zero to five miles around the plant there is very few people, five, 6,000 people. So the population is relatively low, which is a very good thing.

In the ten to 20 miles though, the population grows considerably. We have almost 400,000 people there. This turns into quite a few vehicles. On the left here I say the evacuation time for zero to ten miles is six and a half hours. We still need to select a scenario that's one of the times in the Peach Bottom evacuation time estimate, but we're likely going to go with a daytime winter scenario where schools are in session, people are at work. We want to pick a common scenario we could use for each of the sites. So that time might actually be closer to five hours or so. It's a little bit less for that scenario.

Zero to 20 miles though, now this is moving approximately 260,000 people. You're pushing 20 hours to get those folks out.

The table in the middle or the graphic in the middle of the page says evacuation time. Now, this is, again, very rough because we don't have the sequences done. Nineteen hours and 19 minutes. The start time on this, and this is an artifact of the OREM's model. It defaults to 11:00 p.m. or 2200 hours for an initial evacuation.

So when you look at the little graphic over here on the right, this page, you see 50 percent of the public has effectively left the area. That's really two hours and 15 minutes because the start time is 2,200, and this gives you a good example of what the tail is. You can see 12 hours and 15 minutes here is really 14 hours and 15 minutes after the start of evacuation. Ninety-five percent of the people have evacuated, and you go to 19 hours just to get that last five percent out. So it takes a long time for the tail.

DR. ARMIJO: Is this supposed to be 10:00 p.m. or what's --

MR. JONES: It defaults to 11:00 p.m. When we run the actual numbers we will put a more realistic time in there.

DR. MAYNARD: These population numbers you're talking about, is that the total population within that radius or is that just in the zone that you picked as kind of the worst case?

MR. JONES: In the table at the beginning, at the top up here, that is the total population of zero to ten.

DR. MAYNARD: Okay.

MR. JONES: And it is the total population of ten to 20.

DR. MAYNARD: Okay.

MR. JONES: Well, the next page, page 48, gives you a better breakdown. The evacuation time estimates break out the populations for us, and then we had to do a little work to figure out some of the numbers in the ten to 20 zone.

Again, the values on this page are to illustrate the concept. We'll use real values when we get the source term.

DR. ARMIJO: Are the evacuation times dependent on the start time in real time?

MR. JONES: Not really, not for a long term.

DR. ARMIJO: But if it's really ten or

11:00 p.m., you don't have any schools.

MR. JONES: Correct, and that's why the evacuation model we're using defaults to 11:00 p.m. I don't care today. When I have my scenario then I will set that up so that it coincides with the school day. So those numbers will all be reconciled. That's why I said don't put much into the values you see here. We'll probably start this at eight in the morning on a Wednesday or something to that effect, in which case it would take into account schools.

Page 49.

This is just a graphic that identifies. There's three rings here. The first ring is out five miles. The second ring is ten miles, and the third ring, the largest ring on here, is 20 miles out. Quite an area around the plant, and we're simulating the movement of the public and the different cohorts throughout.

Now, on page 50, I just wanted to show you -- and I don't want to spend much time on this because it's just developing the model -- we actually take the roadway network and we select intersections and then we code this so that we can identify the evacuation route.

Page 51, you know, if these were

transparencies we could overlay 51 on 50 and you would see that our network aligns with the intersections.

And then when you get to page 52, you can see the detail we're putting into this network. To give you an example, the folks that did the evacuation and time estimate for the zero to ten miles probably used two or three times as many nodes as we have. We're not trying to be that precise, but we want to get a decent estimate of the time to evacuate.

Page 53 gives you a sample of the kind of output we're looking at, and this is the data that we then put into WinMACCS, and WinMACCS then crunches the consequences.

The lower right-hand side or the right-hand side of this you can see, and this is very typical of evacuations that start early, move relatively quickly. The graphic slows down very quickly and for a considerable time in this area, and then it starts to pick up towards the end of the evaluation.

This is where when we mentioned earlier WinMACCS can take three different speeds or speeds by grid element. We can use this information to put the speeds in by grid element.

Page 54.

Jocelyn mentioned this earlier, that WinMACCS is now set up for more angular resolution, 16 sectors up to 64 sectors.

Page 55 is probably the same slide Jocelyn showed earlier. We will actually approximate the --

CHAIRMAN SHACK: No, it's not.

MR. JONES: Oh, okay.

CHAIRMAN SHACK: But that's close.

MS. MITCHELL: Different map.

MR. JONES: We'll approximate the evacuation route and we'll be able to select the speeds in each of these grid elements and the directions and move the traffic out, and there are a number of screens in WinMACCS where you establish the other delay times or the precipitations Jocelyn mentioned earlier. The weather scenario in MACCS shows that it's raining. Speeds would be slower, and that's all considered.

So it's considerable, and if this goes to many more rings it becomes tedious, but it's not really difficult at that point.

Page 56.

We expect to fine tune this model with the experience we gain on Peach Bottom, and then move on to Surry.

MR. PRATO: Any questions on EP?

(No response.)

MR. PRATO: That ends the Peach Bottom presentation.

DR. ARMIJO: I'm curious. How are different roads treated differently?

MR. JONES: Each of these nodes that align with different roads, if it's a two-lane road, we input it as a two-lane road, and we have some speed limit that we assign to that. If it's an interstate, we input it as an interstate and we have a speed that we assign to it.

Those are your free flow speeds, and then they're all reduced in the model as traffic builds up on those roads.

DR. CORRADINI: So maybe you said you were going to do this later, and if this is the right time, so for Peach Bottom it's an external event.

MR. JONES: Yes.

DR. CORRADINI: Which is seismic, right?

MR. JONES: Yes.

DR. CORRADINI: So what roadways are killed?

MR. JONES: Well, let's go back to the one graphic on page 49. Again, as I mentioned, zero to five miles, there are very few people that live zero to five miles. There's one bridge within zero to five miles over the river. There's another bridge within zero to ten miles over the river, and as you get out to 20 miles, there are only a total of six bridges.

We don't have the graphic on the screen that would be easier to see, but if you look down here on this I-50 or I-60, the interstate in the lower right-hand corner where it crosses the river, if that bridge were to go out, you would go the other way. You would go radially the other way, in the other direction.

So we're not modeling that, and it might slow things up a bit, but it wouldn't cripple you.

DR. CORRADINI: So let me ask my next question, which is where is the epicenter of this earthquake that you're postulating that crippled the plant?

MR. JONES: Well, it has got to be near the plant if it's going to cripple the plant.

DR. CORRADINI: Well, but I'm pushing the point, which is if I start worrying about an external event that damages the plant, it damages a whole lot of other stuff around it, and if it's not right dead on the plant, it damages all of your evacuation routes.

MR. JONES: It might damage a quadrant. I mean if you think of something like the Frisco earthquake, it damages an area.

DR. CORRADINI: Right.

MR. JONES: It doesn't damage the city.

DR. CORRADINI: So is that being somehow considered?

MR. JONES: Not being considered, and it's not typically considered in assessing, you know, dual catastrophes like that, but it wouldn't shut down the network. It would affect -- it could affect a sector or quadrant, but it shouldn't affect the evacuation. If it was in the south, it wouldn't affect the northern half. It wouldn't take out the network in the northern half.

We are not actually --

DR. ARMIJO: It would degrade the efficiency of the evacuation, you know, because you've got to input it if it's an external.

MR. JONES: It would likely degrade the efficiency, yeah.

DR. CORRADINI: And now I'll push my final point since I don't think it's in your -- so if one started arbitrarily putting the epicenter somewhere around it, there is a worst place where the epicenter would be that would degrade the evacuation and create the consequence that enlarges. Is that going to be considered?

MR. JONES: That's something that can be done, but it's not included in this. I mean, that type of assessment is done not very often in evacuation time estimating, but the capability is there, and it is done once in a while. We are not doing it on this.

DR. ABDEL-KHALIK: I guess to carry this discussion further, if this is an earthquake, presumably a lot of the homes that these people live in would be damaged, and that would impede people's ability to respond to whatever directives they're given. They may not be able to get their car out of the garage, for God's sake.

MR. JONES: It could. The zero to ten mile EPZ has plans to provide busing for people that do not have transportation. There are plans to address people who do not have transportation. That would be many more than they anticipate, I'm sure, but you know, the infrastructure is there to do that.

You know, an earthquake like that would require --

DR. CORRADINI: So this leads me to my final -- I'm on this point for a totally different reason, but I'm using you as a way to educate me. We're way beyond the safe shutdown earthquake. So what's the damage estimate outside the plant?

In other words, will we even forget there's a plant there that there's so much damage? Do you see my question?

So I'm looking for a balance for what you just initiated at the plant versus what the damage has caused in the surround neighborhood because all hell is breaking loose. Nobody cares that there's a plant there. They're just running for a wholly -- they're just moving.

MR. JONES: I don't see that with this site for one reason. There are no large municipalities within the site. You have Lancaster on the border of the 20 mile zone.

DR. CORRADINI: Okay.

MR. JONES: You don't have heavy downtown type infrastructure anywhere within the 20 mile zone. You have rural roads primarily. You have maybe shopping center areas and things like that, but you don't have a city, an urban area in this.

DR. CORRADINI: So I'll postulate one

final point and you'll see where I'm going with this. So let's just say we had Zion. It's not there anymore, but let's say we had Zion. It's 45 miles north of Chicago. Waukegan, Gurney, Kanosha, Racine, it's my area of the world. So I'm very familiar with it.

A very high population area. All right? And the '82 study said that you have very low effects because it always will blow into the lake, but if I had an external event, the chance for evacuation would just totally decimate the chance of anything. So I'm kind of curious how all of this kind of plays together.

Once you start dealing with external event initiators versus internal, that's where I'm kind of trying to understand.

MR. JONES: And that's why it has to be considered site specific as we're doing. When you get into an urban area like that, that's where shelter in place might be something that official --

DR. CORRADINI: Okay, and that will be entered into this as an alternative.

MR. JONES: Well, we're not assessing alternatives.

DR. CORRADINI: I meant for emergency

planning purposes.

MR. JONES: Oh, emergency planning already considers that.

DR. CORRADINI: Okay.

MR. JONES: That's in Peach Bottom as well, and they might decide. You know, that's something we won't be second guessing, but they might decide that shelter in place is the best option until they can get their resources together.

DR. APOSTOLAKIS: Is this fire scenario at Peach Bottom, is that below the cutoff frequency? I mean the fire was a significant contributor.

MR. PRATO: They had put in a number of modifications. There's an express number of physical modifications to improve the separation to take place with the probability of fire, and it was because of physical modifications.

Any other questions specifically on page 5? I'm sorry, John.

MR. MONNINGER: The only thing I'd say is, you know, a lot of these questions you had regarding this scenario we internal to the staff have discussed them and wrestled with how we would handle them all. So that was one of our notions with having this meeting because we don't on some of these issues have a full-blown path forward.

One of our other thoughts was, well, with internal events a significant amount of work has been done over the years, and we have a high -- I don't want to say high level of confidence -- but in terms of the numbers that are used for the internal events, there's a higher level of pedigree. We had some internal thoughts or discussion with, you know, the use of maybe seismic margins assessments, scoping studies in the past. You know, how appropriate is that to use some of these potential sequences in a scenario that we're trying to say is best estimate as realistic as possible?

You know, so I personally would -- my view would be, you know, some of these events where we're potentially using a seismic event that was based on studies from, you know, ten, 15, 20 years ago, you know, is that really what we want to use? Is that really what we believe is the current state of the art, whatever?

So we have been wrestling with a lot of these issues that you have been discussing here also.

DR. MAYNARD: I think that on the emergency planning you said you really aren't making any adjustment for this being an external event.

MR. JONES: Correct.

DR. MAYNARD: You might want to look at that. We brought up a number of things.

The other part is the infrastructure may not be there and as much intact like it is ordinarily. A lot of the same people that may have to be responding to bridge failures or whatever would have E-plan responsibilities that are now going to be split.

So I don't know how you would quantify it. I don't think there's a way to quantify it, but I think just from a judgment standpoint there probably needs to be some adjustment made for that consideration on an external event.

MR. JONES: Well, we can certainly talk about it. I mean, it's very easy for us to cut a bridge in half and model it. It is, and it will tell you the time difference at that access point, but you're right. There are other considerations. The cars might be buried. The emergency responders might be putting out fires.

DR. CORRADINI: The chemical plant might be doing a few things in an external event.

PARTICIPANT: They might be taking all of the attention away.

DR. CORRADINI: Yeah, I guess that's what I was asking about the safe shutdown. If you get to the point that the external event that's driving this is so enormous that you have the community is responding to a whole bunch of things, this is just the way you model the emergency planning to me or the evacuation planning is important to those things.

MR. PRATO: That ends Peach Bottom's presentation. We'll reopen the door between four and 4:15 per the schedule right now. Until then, if you don't mind stepping out.

Do we want to move on to --

CHAIRMAN SHACK: Well, I was going to argue it was time for a break. We will have no other chance to fix the overhead.

Fifteen minutes.

(Whereupon, the foregoing matter went off the record at 3:18 p.m. and went back on the record at 3:37 p.m.)

CHAIRMAN SHACK: We will come back into session.

MR. PRATO: I would like to recommend, at this point, as we go to latent cancer fatalities dose response, we have a few members of the staff from our Office of Research organization, and if we can cover that before we go back into the survey, it may help them a little bit with Tom. So, it's Slide 57.

MS. MITCHELL: I did want to tell you that I did check over lunchtime about the federal guidance report issued. And it is for adults, the average adult which, presumably, averages over some reasonable age value and over two sexes.

So we do use adult values. So I want to talk about the latent cancer fatality dose response model. The released version of MACCS has one latent cancer fatality dose response model, and that is the linear no threshold model.

We do have, in the LNT model, we do have a does effectiveness reduction factor which is applied to chronic doses. Those are the long-term does rather than what happens in the immediate aftermath of the accident. So that it isn't strictly linear, it does have more of a quadratic shape.

DR. KRESS: If you cut off the analysis at some distance, that's essentially a threshold, right?

MS. MITCHELL: The problem with cutting off at a distance would be that big source terms would require one distance to have the same effective threshold and smaller source terms would require another one. So, if you cut off --

DR. KRESS: It would be different threshold, but there would be thresholds.

MS. MITCHELL: Unknown.

DR. KRESS: Yes.

MS. MITCHELL: An unknown invariable value. So, in our original paper, we proposed to use a range of dose thresholds from zero to five Rem, zero being the standard LNT model.

And the Commission approved of that in their SRM. And we believe that it will no facilitate a common understanding, because it leaves the interpretation of the results to the reader, if the NRC doesn't take a position on it.

So we considered several different options, that we would have a range not only do what we originally proposed, to have some sort of expert elicitation and get a probabilistic distribution of thresholds.

And the third option was to use just a point value. So we are going to recommend to the Commission, this is a policy issue. We are going to recommend to the Commission, using 5 Rem in one year or 10 Rem in a lifetime, which is the Health Physic Society position, and represents, in their words, the detectable limit.

That means epidemiologically detectable limit.

PARTICIPANT: If you do that is there anywhere else in the NRC System that uses different thresholds and would the Commission find itself speaking to having two policies?

MS. MITCHELL: Part 20 is certainly based on linear no threshold assumptions.

CHAIRMAN SHACK: It would make quite a difference in calculating your QHOs?

MS. MITCHELL: It may or may not. If you have 5 rem in one year and 10 rem in a lifetime. We'll have to do the calculations. We have only, we have no preliminary results of this, because we have only input values in order to check out the model.

And they don't represent any realistic, presently realistic source terms. So we're just satisfying ourselves that the model works as we propose it to work.

DR. KRESS: Question.

MS. MITCHELL: Yes.

DR. KRESS: Why not also, also, in addition to this recommendation, use zero and see what the difference would be.

MS. MITCHELL: The issue is that the team and the, as agreed to by the Steering Committee, is that they feel it will not facilitate a common understanding because it is open to interpretation unless the NRC takes a position to say they believe one or the other, you'll have some groups quoting one and you'll have other groups quoting the other.

DR. KRESS: Yeah.

MS. MITCHELL: And you will be open to interpretation.

DR. APOSTOLAKIS: Threshold means what? Nothing happens between zero and --

MS. MITCHELL: If you have five rem in a year and ten rem in a lifetime, let us focus on that, because that's what we're recommending. If we go through and we calculate a TEDE value of 5.1 rem, in year one, then we would tally latent fatalities for whatever population received that dose.

If, on the other hand, we calculated 4.99, we would tally zero. However, if you, we would look at the lifetime for the people who got 4.99, in the first year, what did they get in years 2 through 50.

And if that totaled to more than 10 rem, then we would tally latent fatalities.

DR. APOSTOLAKIS: The current policy is there is no threshold, is that correct?

MS. MITCHELL: Yes.

DR. APOSTOLAKIS: So you're proposing to the Commission to change its policy.

MS. MITCHELL: No, no, no.

DR. APOSTOLAKIS: Heaven forbid, right.

(Laughter.)

DR. APOSTOLAKIS: So what you're saying --

MS. MITCHELL: There is an issue between what are you doing to illuminate the situation for calculation for certain severe accidents, and then there is the regulatory arena in which you are looking at reducing by ALARA and all of those other things would remain the same.

DR. APOSTOLAKIS: So the Commission then, assuming they accept your results in the analysis, will be on record saying that for the regulatory activities, there's no threshold.

But from a realistic perspective we have a 5 rem. Is that what they're going to say?

MR. PRATO: It's a little bit different than that. The current policies will induce cancer effects. What we're doing here is we're putting consequences based on detectable.

Below 5 rem we cannot detect latent cancer effects. The percentage is so small it gets mixed up with the rest of the normal observed cancer.

DR. APOSTOLAKIS: But why can't they use the same argument to eliminate the no threshold hypothesis. I think we could have done that.

MR. PRATO: Because it's for public health and safety. We use the --

DR. APOSTOLAKIS: We want to be more conservative. So what I said is we will have two things. One is being very conservation for regulatory purposes, and for realistic purposes we do something else. I think that's what we're saying, huh?

MR. MONNINGER: Yes.

DR. APOSTOLAKIS: Now what, how did you guys manage this and for this project you get all these exemptions from everybody else.

(Laughter.)

DR. APOSTOLAKIS: The agency does. This is incredible.

MR. NEROKA: Just for the record --

DR. APOSTOLAKIS: All sorts of unique things.

MR. PRATO: We are very creative.

(Laughter.)

MR. NEROKA: For the record, this is a recommendation, we don't have an exemption to do this.

DR. APOSTOLAKIS: I know, I know.

MR. NEROKA: We want to be clear on that because this is --

DR. APOSTOLAKIS: I'm sure you will get it.

DR. MAYNARD: Also, the 5 rem in a year is consistent with what's been allowed for radiation workers, and that's been consistent with NRC policy for a number of years.

DR. APOSTOLAKIS: So there is something.

DR. KRESS: This may sound like a strange question. What do you mean by lifetime?

MS. MITCHELL: Fifty years.

DR. APOSTOLAKIS: Fifty years.

MS. MITCHELL: Fifty years.

DR. KRESS: So if he's already 50 years old, he dies at 100.

MS. MITCHELL: But the child dies at 50 instead of 75 or 85 or whatever. So --

DR. APOSTOLAKIS: The average lifetime is considered to be 70 in most calculations.

MS. MITCHELL: But when you have an accident, you've got a population --

DR. KRESS: You've got a population --

MS. MITCHELL: -- that's exposed that has a distribution of --

DR. APOSTOLAKIS: So that's remaining lifetime. Which is kind of high for a remaining, but, I'm with you on that. I'm really with you on that.

(Laughter.)

MR. SHERRY: I'd like to make a slight clarification. We just talked about the QHOs. The QHOs are for latent cancer fatality risk is for within ten miles of the plant. And the kind of accents we're talking about here are the leases that are going to be fairly substantial.

So this threshold probably won't come to play close to the plants that will be further out.

DR. ARMIJO: Let me go back to the issue of this 50 years of keeping track of dose commitment.

MS. MITCHELL: Yes.

DR. ARMIJO: How do you handle people who decided to move into that 20 mile zone, 20 years after the accident? How had not been there before.

MS. MITCHELL: We have a, there is a habitability criterion which we probably will use. The EPA returned criterion for, that says when the dose either decays by itself or is remediated to give less than a certain value, then people can come back.

The idea of Person A leaving and Person B coming back, is not accounted for. You might consider that to be a hidden LNT assumption in the whole calculation.

There are a lot of hidden LNT assumptions in calculating the dose itself. So in calculating the dose, there may be, there may be, there are, not there may be, there are hidden LNT assumptions.

And the idea that one person leaves and a different person comes back, is another hidden LNT assumption. We assume that if there were 100 people in this grid element before, and the return criterion is satisfied, 100 people come back.

DR. CORRADINI: You do not, you're not going to report anything about the land.

DR. KRESS: Actually it wouldn't be fair because this is a consequence model for CDF optimum things and the land, the land probably is, the contamination is probably dominated by the late releases, as well as --

MS. MITCHELL: By the what?

DR. KRESS: Probably as much affected by the late releases as the early. Which you wouldn't get any from the late releases. So it wouldn't be fair --

DR. APOSTOLAKIS: So even the cancers are dominated by early releases?

DR. KRESS: Yeah, if they evacuate. If they evacuate, you don't get any effect from the late releases.

MS. MITCHELL: We would have, we would have folks that would, who would evacuate in the zero to ten miles. We would have the ad hoc evacuation ten to 20 miles.

Beyond 20 miles, we have relocation. That is you would be able to go out, after the plume passage, and with your little meter find hot spots and move people out, relocate people from those areas.

So the calculation would to out to 1,000 miles. And then, as I say, for all of those people who are gone, there are return criterion that would be satisfied, and people who had been relocated, if their return criterion is satisfied, they would come back and reoccupy the housing.

DR. KRESS: But in order to calculate whether or not QHO for latent cancer is met, you would evacuate only out to, you only look out to ten miles.

MS. MITCHELL: It's only out to ten miles, yes.

DR. KRESS: Yeah, and the only people that are going to have a problem are the ones that didn't evacuate because they didn't have time.

So, I was trying to say that the late releases don't even enter into the QHO for that.

DR. CORRADINI: Right, I guess the other way, I wanted to make sure, because this is enough detail on the part that I'm not familiar with is, except of this dose response model where we have variability, all the other assumptions you just went through, this litany of assumptions, is pretty, not pretty standard, but is the standard approach to analyzing it. Correct?

MS. MITCHELL: Yes.

DR. CORRADINI: Okay, all right. So there's no differences? That's what I'm saying. I'm looking for a consistency of analysis.

MS. MITCHELL: The values might be different.

DR. CORRADINI: Right, right.

MS. MITCHELL: But the model is not different.

DR. CORRADINI: Okay.

DR. APOSTOLAKIS: So the Health Physics Society recommends this?

MS. MITCHELL: The Health Physics Society states that below this five rem in one year or ten rem in a lifetime, that you should not quantify the results, rather you should discuss a range of options.

And that below this value, the fatalities either do not exist or are not detectable.

MR. PRATO: We included a copy of that Health Physics paper in your briefing package. So you have that information.

DR. APOSTOLAKIS: So you want me to read it?

(Laughter.)

CHAIRMAN SHACK: Jason, will you explain to me again why this doesn't affect the QHOs?

MR. SCHAPEROW: The quantitative health objective for latent cancer fatality risk is for people within ten miles of the site. And --

DR. KRESS: Most accidents that are dominant are going to get a lot more than 5 rems in that sector.

MR. SCHAPEROW: Five rem near the site is more of like a containment leak kind of number, as opposed to a, you get 5 rem at the low population zone distance for containment leakage.

This is a containment failure or a bypass, so you're going to have hundreds of rem, hundreds of rem per year.

DR. APOSTOLAKIS: How many rem?

MR. SCHAPEROW: Hundreds.

DR. KRESS: If you're going to have prompt fatalities you're going to get 500 or 1,000 rems.

MR. SCHAPEROW: Yeah, it could be a thousand. Well, actually if the wind changes, now we're getting a little better now with this modeling of breaking down the wind direction and we now have more than 16 directions, now we've got 32, 64.

So we might not see quite as high peak doses from the calculations. It's going to be more smeared out over the area. Which makes sense.

CHAIRMAN SHACK: At .1 percent of your thousand, don't you come way down in the dose that you're allowed to do and still meet the QHO?

MR. SCHAPEROW: I don't understand your question.

DR. CORRADINI: His point is if you can be that specific, you're going to have less people dosed at a high value, so you'll have more of a chance to meet the QHO. That's what I thought he just said.

CHAIRMAN SHACK: No, to meet the QHO, if that guy is only going to have .1 percent chance of getting the cancer, he can't take 1,000 rem, you know. He's going to have --

MS. MITCHELL: If you have 1,000 rem, the person will be dead of a prompt fatality.

CHAIRMAN SHACK: Right.

MS. MITCHELL: It turns out that one, we, while we were doing everything else, and I didn't bring it up. We corrected a small handful or so of bugs. And there was a bug in MACCS that would allow you to kill people twice.

(Laughter.)

MS. MITCHELL: So the case that you have 1,000 rem exposure, they would die promptly, but then they also would have some probability of dying of latent cancer fatalities.

DR. ARMIJO: And they can still vote.

MS. MITCHELL: And they can still vote, right, in Chicago.

DR. CORRADINI: In South Texas.

(Laughter.)

DR. APOSTOLAKIS: I think some people deserve it, anyway.

CHAIRMAN SHACK: But even .1 percent, don't I multiply the 1,000 by .001?

DR. APOSTOLAKIS: One thousand is early death.

CHAIRMAN SHACK: Right, and --

DR. APOSTOLAKIS: It's not cancer.

CHAIRMAN SHACK: It's early death.

DR. APOSTOLAKIS: I think about 500 it starts being early, right? Maybe 400 rem.

MS. MITCHELL: The threshold, there's a threshold for the LD 50.60 for bone marrow is somewhere in the range of 400 rad to the bone marrow.

But there is a threshold where the more radiosensitive people, people who are otherwise ill, may very well die at maybe 175 rad to the bone marrow. Don't quote me on that number.

But it's a number in that range. And then it has, it has this sort of S-shaped functional form that pivots around LD 50, with a shape factor.

DR. APOSTOLAKIS: Another thing, though, speaking of the Commission. Think about it, for Yucca Mountain. In 10,000 years they want 15 mili-rem a year.

DR. CORRADINI: But that's the groundwater. That's a groundwater permit.

MS. MITCHELL: Groundwater is 4 rem, 4 milii-rem a year.

DR. APOSTOLAKIS: No, it's a milii-rem to the reasonably, maximally, exposed individual.

DR. CORRADINI: At the bottom.

DR. APOSTOLAKIS: Yeah.

DR. CORRADINI: Fifteen milii-rem per year.

DR. APOSTOLAKIS: And here we have, below 5 and nothing happens? It's not detectable? They're talking about, what, two or three --

Fifteen milii-rem when below five is not detectable? I mean, come on, guys.

DR. MAYNARD: You've got apples and oranges there. Because even at a power plant, you're not allowed to have five rem at the site boundary for the public and stuff.

We're talking about an accident situation here.

DR. CORRADINI: Just so we're clear, you're ignoring the fact, the seismic event at Yucca Mountain gives you hundreds of thousands of rads, if you believe their analysis. The if is there.

DR. APOSTOLAKIS: No, it doesn't.

DR. CORRADINI: Yes.

DR. ARMIJO: So the use of this value, the five rem sort of appear to be biasing the result towards underestimating the consequences.

MS. MITCHELL: Are you asking my personal opinion on the subject?

DR. ARMIJO: Yes, ma'am.

MS. MITCHELL: I think you're exactly

right. I think that it, that it does appear to bias the results.

DR. ARMIJO: Wouldn't that take away from the leakability or the credibility of the exercise?

MR. PRATO: But what's the alternative. To report full values for a single consequence and leaving it up to the individual to try and interpret that?

DR. KRESS: You could do the zero.

DR. ARMIJO: Right, you can do the zero.

DR. KRESS: And explain what it is, and it wouldn't be hard to interpret it.

MR. MONNINGER: We wanted, and we talked about doing the range or doing zero, three, five, etcetera. And I guess the thought was then, you know, dependent upon the user or the results out there, they're going to pick the number they want.

And we would get back in the same situation we were in the '82 study. We don't necessarily believe zero is the right value, but certain organizations or individuals may propagate that number out there.

So we believed it was more appropriate to come down to a single value and use that value for purpose of this analysis.

DR. ARMIJO: But some may argue that even though something is not detectable, does not mean it doesn't exist.

MR. MONNINGER: They may argue that, yes.

MR. PRATO: And we would argue that as well. I mean that's not an issue that we're trying to hide or deny. And the reality of it is, is that there may be a small percentage of additional health affects, as a result of this.

But, this is a consequence analysis. We are charged with reporting effects on the public. How do you report effects that you can't measure.

DR. ARMIJO: I guess I have to think through the process. But I'm just concerned about the credibility of the outcome.

You know, you spend a lot of time and effort doing this and you want to make sure that whatever you come up with is something that people will view as worthwhile.

PARTICIPANT: But if you use a linear no threshold, to me that's propagating an incredible situation. Things that, you know, we're endorsing something that at least a lot of us don't believe in.

And this is supposed to be the best estimate, realistic, and I think you ought to stick to your guns.

DR. APOSTOLAKIS: Until the Commission --

PARTICIPANT: Until they tell you know, or something. They asked you for a realistic, best estimate, and they're telling this is how to do it.

MR. PRATO: Just so that you understand our current plan, our current plan is to put this in a paper and present it to the Commission, the current plan.

DR. APOSTOLAKIS: That's good.

MR. PRATO: Okay, any other questions on this subject? Any other comments?

DR. APOSTOLAKIS: Is this the last subject or there's more?

MR. PRATO: No batteries --

DR. APOSTOLAKIS: To learn what?

MR. PRATO: Okay?

DR. APOSTOLAKIS: Sure, we're learning something.

MR. PRATO: Go back to Slide 6, please. Richard, you're up.

CHAIRMAN SHACK: Let me get my first question in. Surry, in its LRA says their internal events, you know, CDF is three times ten to the minus five. Which has lost an order of magnitude.

MR. SHERRY: Well, there's several reasons for that. One, their internal events include internal flooding, okay.

DR. APOSTOLAKIS: Externally events include --

MR. SHERRY: Their internal events model.

DR. APOSTOLAKIS: Oh, they put it in?

MR. SHERRY: They include internal flooding also, which is significant for Surry.

DR. APOSTOLAKIS: By the way, this thing about fire at Peach Bottom. Are you sure the frequency is below this, ten to the minus six?

MR. SHERRY: Yes, sir.

DR. APOSTOLAKIS: Because it was a major contributor to the health effects.

MR. PRATO: They've made some significant modifications, at least the information we got on our site visit.

DR. APOSTOLAKIS: All right.

MR. SHERRY: And the second reason that the number is in the low to mid, ten to minus six after, excluding flooding, is that we, in the SPAR model we used the latest industry information on the component failure rates and indicating event frequencies.

And that has significantly brought down

the frequencies of many of the internal event sequences.

And, I'm not sure that Surry has updated their model to include the latest information, industry average information.

CHAIRMAN SHACK: I can hardly wait to see what you're going to compute at South Texas.

(Laughter.)

DR. APOSTOLAKIS: So what did we learn from this, Rick?

MR. SHERRY: What I wanted to point out on this slide, this is the sequence groups for Surry. In this case, we have two sequence groups identified in red, which are above our screening criteria.

They are below ten to the minus six, but they are both containment bypass sequences. Sequence 2 is a steam generator tube rupture sequence. Sequence 3 is an interfacing systems look in the low pressure injection line. Okay.

It turns out that these are both quite similar in character.

DR. APOSTOLAKIS: This is a classical V sequence, right?

MR. SHERRY: V, yes. And sequence groups 2 and 3 are, we have selected to carry forward in the circuit analysis from the external events analysis. Okay.

The steam generator tube rupture sequence basically progressed mainly due to human error. Failure to isolate the faulted steam generator, failure to cool down to pressure AC reactor.

And then, in the last stages, the action of again failure to depressurize and go on to residual heat removal.

Eventually, you go to core damage because you have continued to inject water through the high pressure injection system. You empty the RWST and the Operator then is assumed to fail to either refill the RWST or to switch over to an alternate water source, like the other units refilling water storage tank.

Okay, so, as I said, this sequence is dominated by human error. And it's a, go back. And it's a fairly long sequence in terms of the action and progression.

With a nominal leak rate of 459 gallons a minute, the action sequence will last, until you go to core damage for the initiating event, approximately 16 hours, Jason?

MR. SCHAPEROW: That's assuming you just stay at pressure. If the pressure doesn't come down.

MR. SHERRY: But that's a --

MR. SCHAPEROW: It's a long event.

MR. SHERRY: It's a long time. This slide then shows you what the systems are available. Essentially all systems are available for this event.

However, once you drain the RWST and are forced to switch to recirculation, you don't have any water in the containment sump, so you, part of your recirculation systems will work. Then it's assumed you go to core damage by that.

From lack of injection during switch over to recirculation.

DR. APOSTOLAKIS: So this probability or frequency of five to the minus seven, contains the failure of the operators, why so late the faulted steam generator.

MR. SHERRY: And several other related.

DR. APOSTOLAKIS: How is that probability estimated? Is this the licensee's estimate?

MR. SHERRY: This is a SPAR model.

DR. APOSTOLAKIS: Oh, SPAR-H?

(Laughter.)

DR. CORRADINI: Oh, my gosh, here we go.

MR. SHERRY: But the licensee model, okay, gives essentially the same number. Okay, the same range.

DR. APOSTOLAKIS: Do you remember the number?

MR. SHERRY: Not off the top of my head.

DR. APOSTOLAKIS: See, that's another problem with these frequencies. I mean some of these probabilities come from models that are questionable.

CHAIRMAN SHACK: Well, at least it's not excluded, George.

(Laughter.)

DR. ARMIJO: -- bypass start in this event? When do you start releasing?

MR. SHERRY: Well, you wouldn't start releasing any nuclides until after you switch over to recirculation and then boil off the water, go to core damage.

So it would be quite late. I don't know, a day, would not be an unreasonable estimate.

DR. ARMIJO: But if the operator fails to isolate the faulted generator and depressurize the reactor, wouldn't you release regular nuclides from the secondary valves, early on?

MR. SHERRY: Yeah, that's the assumed pathway. It's basically up through the break in the steam generator and then out through a safety valve, which may or may not be stuck open.

MR. SCHAPEROW: I'd like to ask if we could maybe leave this to, I'm going to go through more of this.

DR. ARMIJO: Oh, okay, sorry.

MR. SCHAPEROW: And scrubbing the steam generator and all that sort of thing. Yeah, I'm going to go through the whole thing, hopefully.

DR. ARMIJO: That's fine, thank you.

MR. SCHAPEROW: Sorry.

DR. APOSTOLAKIS: So why aren't the fan coolers available?

MR. SHERRY: The fan coolers for Surry, our first, they're not engineered safeguards. They're just normal fan cooling system. And if you, it's not important for this particular sequence, but if you actually get water into containment, you'll flood the lower portion of the system.

And three, the system gets isolated on a containment isolation signal.

DR. APOSTOLAKIS: The containment sprays? Oh, no, the injection is available, but recirc isn't open.

MR. SHERRY: This is the interfacing system

LOCA in the low pressure injection system. Basically the sequence involves value of two check valves in the low pressure injection discharge line or discharge path.

Then, subsequent rupture of the low pressure piping in the system outside containment. And the inability to isolate the rupture. And both the licensee model and the SPAR model, essentially dis-assess the sequence to that point and then say, okay, it's core damage.

And we basically say, okay, how does core damage occur? Well, in a similar fashion to the steam generator tube rupture, you still have high pressure injection available.

You continue injecting water into the vessel leaks through the break outside of containment. Then you go to core damage when you empty the RWST and can't go to recirculation cooling, for lack of water in containment.

Again, it's quite similar to the steam generator tube rupture. Next slide. For the Surry plant we identified two external event-initiated sequences. The first being a long-term station blackout.

The second being a short-term station

blackout. At Surry, these can be initiated by a seismic event or potentially a flooding event.

DR. CORRADINI: Is the flooding from their lake?

DR. APOSTOLAKIS: Internal tanks.

DR. CORRADINI: Internal tanks?

MR. PRATO: The main configuration, the service water system, they pump up to a higher elevation and there's a long canal.

DR. CORRADINI: From the lake?

MR. SHERRY: The intake canal.

DR. CORRADINI: Yeah, the intake canal from the lake, okay.

DR. APOSTOLAKIS: Is that what it is?

MR. PRATO: It's just a canal. They're on the James River and they pump water from the James River and it's not much.

DR. APOSTOLAKIS: All right. So that canal fills due to some --

MR. SHERRY: No, the canal doesn't fill. It's the, conducts your, basically conducts your cooling water lines, that gravity feed.

DR. CORRADINI: Internal flooding is when you have, one of your internal pipes, something that breaks and water comes in.

MR. SHERRY: And so it's essentially failure of the pipe or a valve in that system.

DR. CORRADINI: But fed by this system?

MR. SHERRY: But gravity-fed.

DR. APOSTOLAKIS: I'm not saying to you it's not necessarily due to an earthquake, that's what he means.

MR. SHERRY: No, it could be a spontaneous, a round of fire in the pipe. It could be initiated by an earthquake, but there are internal initiating events which lead to station blackout.

Basically, you have a large flood in the turbine building, it overflows rear walls and you flood the emergency switchgear rooms.

And, just before we leave this slide, this is, the long-term station blackout. It has availability of DC power early and the turbine-driven auxiliary feedwater system.

Next slide. Similar, except you do not have DC power, you do not have a the turbine-driven aux feedwater system. And that's essentially the only difference between those two external event sequences.

DR. CORRADINI: But in all four cases, they all have the same signature in terms of how the system degrades. Oh, no, this one's available, PORVs available, so you can depressurize here.

But all of them are station blackouts, so they all degrade at high pressure.

MR. SHERRY: Well, the external event sequences are station blackout. The internal event are containment bypass.

DR. APOSTOLAKIS: And this answers the only question from this morning when the question was where do we consider containment systems, drain failures and that's what you see from these sequences.

The containment systems don't really come into play in these sequences.

MR. PRATO: We went over this slide. Insights, over insights, Page 18.

MR. SCHAPEROW: Again, as Rick just pointed out, we had, we've got four sequences, as a result of our screening. Two internal events bypass sequences.

One is a lowhead injection ISLOCA and the other one is a spontaneous steam generator tube rupture. For external events we've got a long-term station blackout and what we call a short-term station blackout.

In the ISLOCA Sequence, the sequence starts off with the discs in two check valves in series, in the containment, failing. So now these two discs have failed, we've now got high pressure, RCS pressure water, out in the Safeguards Building outside containment.

And that piping out there is not qualified to withstand these high pressures. So the assumption here is that as a result of the RCS pressure in the low pressure piping, that the low pressure piping starts to leak.

I'd also like to note that the valves are in a six inch pipe, and the pipe hasn't been cherished. That may give some, some sense of the hole, so called hole size in the system. It's not a huge hole but it's not tiny either.

Well, I guess it's hard to know how big the hole is because we're assuming a leak outside containment. I don't know if there's been a detail structural analysis of the piping system out there.

It could be a high pressure sequence, it could be a low pressure sequence, depending upon the hole size.

For mitigation, we do have, we've kind of lost our low head injection, because this is where it goes into the system, so you're not going to use that.

You'll just empty, empty the water out of the break. So we would rely, for this sequence, on high head injection. And we do have, we do have three pumps available, 150 GPM per pump.

So, and this is significant. I mean decay, I think just to make up for decay power at half hour into the event, you have to, you boil off about 100 GPM, so this looks like it's in the right range to handle it.

This seems to be in the right range to handle, to handle decay power.

DR. ARMIJO: What is Surry's terminal power?

MR. SCHAPEROW: About 2,500 megawatts.

DR. ARMIJO: Twenty-five hundred.

MR. SCHAPEROW: In that range. I'd also like to note that because of the location of this piping, and the low head injection system is in the bottom of the Safeguards Building, it's an area that could be flooded and filled up with water.

So, eventually, there is a release, it would probably have to pass through the water.

DR. CORRADINI: But, if I understand the logic is that you say prevent. You mean delay, right? Because once you lose the RWST, you're going to go into degradation?

MR. SCHAPEROW: That's assuming that nobody does anything, that's correct.

DR. CORRADINI: Oh, we're back to that.

MR. SCHAPEROW: Well, we've got a break size of, first of all, we don't know what the break size is, it's an unspecified break size.

It could be small. Even if we were using all three high head injection pumps at 150 GPM, that's 450 GPM, that would, that would take 14 hours to pump the water, RWST inventory out the break.

That's the first one. Then there's another one right next to it. And there's another RWST that has a cross connect, so they can switch over if you realize what was going on.

So, it's, things are starting to look like they might be mitigated again. We're kind of getting into a scenario where things were so long, that we're starting to question some of the assumptions here about, well, it goes to core damage.

I'd also like to toss in that we do have a portable generator and portable pumps available here. We did do a site visit to Surry, about two or three weeks ago.

They showed us their new portable pumps. They've got two high head pumps. They do, not RCS pressure, they do about 900 pounds, they can deliver

100 GPM, 900 pounds.

At lower pressures they can deliver about 500 GPM. They also have a low pressure, portable low pressure diesel-driven pump which delivers about 3,000 GPM.

And they purchased other things, too. They've been working on having some additional capability, some portable capability in this area. Again, as a result of the security work.

DR. MAYNARD: Don't they also have an isolation valve? Did you say the isolation valve fails or they fail to close the isolation valve?

MR. SCHAPEROW: The isolation valve is, I believe it's --

MR. PRATO: It's locked open, and they would be flooded very quickly. So they don't have access.

DR. MAYNARD: They don't have access to it?

MR. PRATO: The external isolation valve, they won't have access to it.

MR. TINKLER: It's also true that if this scenario stays at high pressure, AFW is available throughout this entire sequence. So after 14 or 20 hours, whatever you think, the likelihood that you'd be pressurized through the secondary system is pretty high, okay.

So, Jason's argument about, you know, your, the leak rate would be reduced because the RCS pressure is being driven down by the normal cool down, the preferred cool down path through the secondary side.

This thing gets stretched out pretty long. And so, and Jason is just reflecting the fact you're looking at 20 plus hours or so, how much, how many shift changes, how many recommendations from the TSC, don't get followed.

MR. PRATO: And there's 800,000 gallons of cold water between the cumulative RWSTs that's going to flush through there to cool down.

MR. SCHAPEROW: Also, as Rick pointed out, the other sequence, very similar, the spontaneous steam generator tube rupture.

DR. APOSTOLAKIS: Let's talk about this mitigate, this bullet about mitigation. Yeah, on 19. We just reviewed NUREG-1852, operator actions during a fire.

And the staff made a very clear statement there that the operator actions during a fire, this is not risk-informed. Must be both visible and reliable.

Okay, and they go on and they list ten or so criteria that the Licensee may use to, in fact, argue that yes they are reliable.

In other words, if the available time is ten hours, or let's say two hours. And then they have to demonstrate that their time for action is less than two hours, with sufficient margin, so that the staff would believe them.

Now, here you seem to be focusing exclusively on the feasibility, but not the reliability of the intervention. And even in the Peach Bottom case, you told us, oh, they have this portable generator and this and that.

So the probability that they will do it is one. Well, yeah, I mean it's sufficient to prepare the core damage, but is it going to happen.

And why, in the case of fire, we put these extra criteria on the Licensees. But when we do it, we don't use any criteria.

MR. SCHAPEROW: I'm arguing on the basis of the long time periods available to act. Much more than two hours, 20 hours, ten times as long, it may be more.

MR. PRATO: We put basically a time line. We identified the initial conditions and then we went to everything that was remaining available to them.

We tried to identify how long it would take them to implement them. And not in parallel either. It was basically in a series. And we asked that they use conservative numbers and they provided us with that input.

DR. APOSTOLAKIS: I think, though, it would be a stronger case if you actually consulted those criteria, and had a paragraph or two saying, yeah, you know, we obviously meet all that stuff.

It really doesn't look good if we ask the Licensees to follow criteria, but then we don't.

MR. MONNINGER: I think -- this is Joe Monninger. Yes, so the same organization we are responsible for NUREG-1852. And one of the things I would say there, that there is a difference between this study here and NUREG-1852.

NUREG-1852 was put together for guidance for Licensees to use or to meet in terms of exemptions from requirements. You know, so there is conservatism, there is bells and whistles placed upon that to provide assurance about a quick protection.

Whereas, here, we are trying to be, you know, more realistic, more best estimate and really take maximum advantage of all the areas we can. I mean, other examples within, you know, the PRA space, typically for like, we were talking about batteries before.

You know, even within your PRAs, your battery life may be assumed to be two hours. And there are certain requirements placed on those battery life, you know, that they get out of Reg Guide 1.200, and the ASME Standards, etcetera.

But there is capacity beyond that left. And we are trying to take advantage of that.

DR. APOSTOLAKIS: I understand this, you know, that's in regulatory specs, but obviously the criteria listed reflect the views of the staff as to what is important.

And I remember they referred to the environment that the fire creates. So in this case you would address the questions that Mike Corradini asked earlier, but the earthquake may damage other things, right.

You're looking at the context within which the actions take place. And I don't think it would be too hard for you, especially if, as Jason says, you have very long times, to cite those criteria and say, yeah, what are we meeting.

DR. MAYNARD: First of all, this is an incredible sequence of events, anyway, because you're having to assume a lot of errors and there are things that the operators are exercised on a lot.

This is one where it's fully demonstrated frequently in the simulator and practiced and everything.

DR. APOSTOLAKIS: It's not just for Peach, it's for the methodology. I mean for Peach Bottom it was a seismic. The criteria are much more relevant there than here. It's not a big deal. Not everything we raise is a big deal.

MR. DUBE: Can I add a comment on this? As the former manager of the Accident Management Team at a couple of sites, I would say, though, George, your point is well taken.

In that, you know, the initial blow down here, even it's a couple inch break, has got to be a couple thousand gallons a minute of 550 degree Fahrenheit water, you know, into the Safeguards Building that's going to create a rather harsh environment.

Not to mention there is going to be some radioactivity and the site staff is going to be extremely sensitive to the fact that they detect radioactivity being emitted outside the plant.

So, I think we still have work to do

regarding the accessability of the various points where we may be, the Licensee might take credit for injecting water from alternate sources and so forth.

It's not, I think there's still work to be done here, because the environment that would be created, even if we have tens of hours, is still something to consider.

MR. PRATO: Just so you understand, we did take into account accessability. We wanted to make sure that they had access to the areas where they were taking credit for the mitigative measures. So we did consider that.

MR. SCHAPEROW: Yeah, like we didn't take credit for being able to go down there and isolate the system, but we did, but the fueling water storage tank is not down there in the Safeguards Building.

It's out, you know, outside the building. So it's something that one could get to, to refill.

MR. DUBE: Okay.

MR. SCHAPEROW: I'd like to turn to the spontaneous tube rupture which, as Rick noted, is very similar. This one we can maybe argue that we have a little better handle on the break size.

We have had experience with tube ruptures, they rupture one tube, we've actually got data on the tube ruptures.

For this sequence, the initial condition if the operator failed to diagnose the tube rupture and follow their procedures.

So, again, they result in pumping their fueling water storage tank inventory into the RCS to make up for the break. They don't know where the break is, but they know they have one, because they're using all their water to keep filling the RCS.

Again, if they're pumping full with all three pumps and they've got a break of about one tube, which is about a 450 GPM, they will deplete the one unit's RWST in about 14 hours.

Again, they've got a cross tie. Assuming they didn't know where the break was, but they knew they were depleting their tank, they could cross tie to the other, the other fueling water storage tank.

Similar arguments here about time. A lot of time. Arguments that are made, there's going to be additional crews of operators coming on. I mean this thing is taking place over, probably a couple different shifts.

Assuming they have a break somewhere, they don't know where it is, there's going to be, the TSC will be, their on-site Technical Support Center is going to get staff up.

Maybe their off-site Emergency Operations Facility, and the NRC might even get staffed up. So they may have a lot of help on this one, if they don't know what's going on.

Because this is not a blackout, I mean we're in a situation where we basically have got everything available. We've got all of our injection systems.

Of course, we deplete the RWST. And another thing that maybe helpful, also, is the RCS pressure drops, as it will doing a tube rupture sequence.

Eventually, when pressure drops enough, as maybe naturally it will drop enough, you may be able to start your decay heat removal system. And also the steam generator pressure is going to be actually higher than the RCS pressure at some point.

You may actually get some back flow out of the RCS, so this is kind of a little tricky. Similar conclusion, similar sequence. The mitigation does seem to be feasible in this case.

DR. CORRADINI: So, I guess, can I just break in? So the portable generator and pumps I'm discounting for the moment. I'm still struggling with the so you've done or are doing calculations that indicate that you don't get into any degraded core state.

Just by the, just by the available systems you have on and the reduction in decay heat with time?

MR. SCHAPEROW: We have not started calculations for Surry with MELCOR yet. We intend to do that very soon. These are preliminary insights from, basically, our meeting at, our discussions with the plant.

Our review of the systems available and our own experience in this area, on previous assessments.

Yeah, actually, the portable generator pumps, theoretically, if you had any idea what was going on, you wouldn't need them, because you've got all the plant systems.

You may, maybe you would call something in the portable pump into play to refuel an RWST, I don't know.

Turning to external events, Slide 21. The long-term station blackout, we do have a failure of off-site power. Failure of both diesel, so basically we don't have any AC power on-site.

Surry determined driven aux feed water

system would remove decay heat. As the sequence continues, the RCS water level will start to drop because we're not feeding the reactor cooling system.

We have water boiling off. We also have some leakage from the reactor cooling pump seals. Now, regarding the turbine driven off speed water system, for this sequence the battery is going to be used to indicate steam generator level and to control the aux feed water pump.

We've talked to the Licensee about their, their estimate of battery life. Their PRA does have a conservative estimate of eight hours for battery life.

I expressed surprise when we were there and said, well, how about, Peach Bottom has only got two hour battery life for their conservative estimate.

And they said, well, ours is eight. Their batteries must be more substantial.

DR. MAYNARD: Well, that depends a lot on what your DC loads are that you require. I mean it's not only the battery, battery size and battery power, but also what your loads are that you're requiring.

MR. SCHAPEROW: And they have less loads. They also, the thing that surprised me, they said that they didn't, they don't have a DC load shed procedure.

If they were on the batteries, they don't have any procedures to start shedding DC loads. So maybe they don't have any loads on the batteries.

DR. APOSTOLAKIS: So what kinds of loads would one plant have but another would not?

DR. MAYNARD: Well, one might have some electric pumps, some electric DC pumps, which may draw some current, but usually it's instrumentation and valve control is what you're really using most of the DC power for.

MR. SCHAPEROW: This is a situation where we are on a battery since we've had a station blackout. So, once the battery is depleted, they would need to manually control their aux feed, the turbine driven aux feed water pump.

They do have a portable generator. They've got procedures for hooking it up to indicate level.

DR. APOSTOLAKIS: So you will take the eight hours and use it, right?

MR. SCHAPEROW: Yes.

DR. APOSTOLAKIS: Because the Licensee said that.

MR. SCHAPEROW: Well, actually, I'd like to do it using a bigger number than the eight hours, since eight hours is a conservative estimate. I'd like to find out what is a realistic estimate.

So, for eight hours, nothing is going to happen. The turbine, well, I shouldn't say that. You'll continue to feed the steam generators. You will have leakage out of the RCS through the pump seals.

Which, brings me to my next bullet. Leakage is estimated at 21 GPM per pump. This is a standard number. The issue here is that as the core damage starts to progress, you're going to start getting high temperatures in the RCS.

And you may get seal failure. At which point your leak load is going to go way up. Probably like ten times that big.

We do have research planned to provide a more realistic estimate of seal failure timing, they're working to get a project in place with the RCP seal experts at AECL, who've done a lot of work in this area before.

We'd like to get, again, a most realistic estimate of seal failure timing. Because this could have a big effect on the accident progression.

On the other hand, Surry does have procedures and portable pumps to provide make up to the reactor cooling system. The procedures involve hooking up portable power supply to open up the relief valve on the RCS and to use their diesel driven portable pump to fill the RCS.

And this, again, these are new procedures, they just developed them. They just purchased the equipment. They recently built a small building to house this new equipment.

Again, we went to the site, they showed us their new equipment and where it was stored and all. And, again, it's starting to, this one looks like mitigation to prevent core damage is feasible.

With regard to the short-term station blackout, the, this is a more severe event because we also have a failure of DC power. For the non-seismic initiator, I notice that you had flooding on yours.

I still have fire on mine for some reason. Maybe you can clarify that for me, I don't know.

MR. SHERRY: It can also include fire.

MR. SCHAPEROW: Okay, so it's for the non-seismic initiators, it's a less severe event because we have turbine driven aux feed water pump intact.

It will, when you lose power to the turbine driven aux feed pump at Surry, the pump will automatically come on, with no power. It just starts up and runs at the designed speed.

It's not like that at every plant. Because we've done similar analysis, I think it was at Sequoyah. But Surry has got this feature, where the turbine driven aux feed pump comes on when it loses power.

The operators would need to take control of the feed water pump to prevent overfill of the steam generators. So that's on the secondary side.

On the primary side, the operators could make up for the pump seal leakage with a portable pump that they have.

For the seismic initiator, the sequence is more severe. For this seismic initiator it was, this involves direct mechanical failure of the turbine driven aux feed pump.

So this is basically a sequence with no injection. So it's a limiting scenario in terms of timing prior to core damage.

DR. CORRADINI: So this is the only one that, by hook or by crook, you can't get away from core damage?

MR. SCHAPEROW: Well, the last bullet, we're evaluating the availability of --

DR. CORRADINI: I don't mean to phrase it that way, but that's --

MR. SCHAPEROW: The portable equipment is sitting there in the small building outside of protected area. I guess the question is, is can they get to this equipment? Is there a place where they can hook it up?

How bad is the seismic event? Does it destroy the building it's in? We need to look at that.

DR. CORRADINI: So, I guess, let me, I don't want to pick on Dominion, but, so they now have a new building with pumps in it that are portable. And upon --

MR. SCHAPEROW: Diesel driven.

DR. CORRADINI: Diesel driven, that can be dispatched for various purposes?

MR. SCHAPEROW: That's correct. And there's time involved with that. I mean there's --

DR. CORRADINI: Quote us a number, eight hours, everything is done within eight hours?

MR. SCHAPEROW: There's a number of, they have to, it takes them a little while to get the thing, because they're skid-mounted. They have to take them out of the building, bring them to the hook-up location and connect them up.

DR. CORRADINI: And how does, since I don't understand this, this is outside of the design base, so how do I assess reliability?

MR. SCHAPEROW: I think it's being included in their commitments to us through issuing an - SE already?

MR. PRATO: We have a documented report from each Licensee as to what they're going to do with regards to B5B. That information, and we're starting to get into security-related area.

DR. CORRADINI: Oh, excuse me.

MR. PRATO: But, the bottom line is, is that the Licensee is committed to do certain things and they document what they're going to do.

And they're in the process of implementing it and proceduralizing it at this point.

DR. CORRADINI: So for a different reason, they're going to have to show reliability? For a different purpose, they have this here and they're going to have to show reliability up to some level, is that what you're saying? I'm trying to understand --

MR. SCHAPEROW: Yes.

DR. CORRADINI: -- within the context so we can discuss it.

MR. PRATO: The question that came up at the site was if the seismic event is severe enough to collapse a building, not only would the pumps be available.

What we did during our analysis is, typically, they have three pumps. They have two high pressure pumps, one low pressure pump. They told us that they typically keep the low pressure pump outside.

And they typically keep the high pressure pump within that building that they recently built, along with a fire truck that they have right outside there.

So we gave them credit for the low pressure pump, drawing our analysis. We're still trying to work through all of this to try to identify would the high pressure pumps be available?

Do we really consider the building falling down based on the degree of the seismic event? Is it .5, is it one? What kind of results can be expect? We're not sure yet.

And we're still trying to work through that assessment.

DR. CORRADINI: Thank you.

DR. ARMIJO: In this total loss of feed

water event, can't they do feed and bleed?

MR. SCHAPEROW: The seismic initiator?

DR. ARMIJO: I guess it depends on what you, right, it depends on what you're assuming what else fails.

MR. SCHAPEROW: Yeah, the question is what pumps are available.

MR. SHIU: This is an SBO sequence, so you won't have power for your feed.

CHAIRMAN SHACK: Until he hooks up this portable pump, he's got nothing.

MR. TINKLER: And I heard you, if you say there's some concern that it might take up to six to eight hours?

MR. SCHAPEROW: I think they've committed for a certain number of hours to get it in place by.

MR. TINKLER: Well, you've boiled the steam generators dry long before that, if you had a direct mechanical failure of the AFW. So, they'd have to get it going sooner.

You know, the short-term SBO that we do for thermally-induced steam generator rupture, steam generators boil dry in an hour and a half. And the core starts heating up pretty severely in about three and a half hours.

MR. PRATO: I don't remember what the time was. Jason seems to remember six to eight hours.

MR. SCHAPEROW: I think they said they can show that they can do it within eight hours, but they think they can probably do it in about two, if memory serves me.

MR. TINKLER: Eight wouldn't be quick enough for even a best estimate calculation.

MR. SCHAPEROW: I don't remember the exact number, but it was on the order of a few-ish hours. It wasn't ten minutes, it wasn't a day, it was hours.

MR. TINKLER: See, that would be okay, you know, if had, if you didn't have that direct failure of the turbine driven AFW. And then you're trying to make up for seal leakage and things like that.

But, an immediate loss of turbine driven AFW are a really constraining set of facts. Because even if it ran for a little while, you know, the other calculations we did were, even if it runs for a little while, you get one refill of the steam generator, it could push the accident progression out another eight to ten hours.

But without getting any refill of the steam generator, it would go quickly.

DR. CORRADINI: So, back to my, I didn't

mean to interrupt, but my question is that so I thought this one was going to lead to something that would lead to a source term.

But what I'm hearing is this may not either. So there is a possibility that Surry will have essentially zero source term with mitigating efforts?

MR. SCHAPEROW: It depends, this last one is the question mark, as you said.

MR. TINKLER: This could be another case of one with and one without.

DR. CORRADINI: That might not be a bad thing to do. That would be a suggestion.

MR. TINKLER: Because it's the same kind of issue, a seismic condition that effects operability.

DR. CORRADINI: And I guess back to --

DR. MAYNARD: I also think that there have been some changes made at all these plants within the last couple of years, that provide a lot more mitigation than what plants did back when the original studies and stuff were done. Pumps and generators and --

DR. CORRADINI: Sure, sure.

MR. TINKLER: Absolutely, and we're reflecting some of that. I mean, but you could also question, as John mentioned earlier, what about that fragility model of the turbine drive AFW that causes it to fail on seismic, how realistic is that?

Is it realistic? Or was it just expedient? That turbine driven AFW is considered to be a fairly robust kind of simple thing, compared to a waterwheel.

DR. APOSTOLAKIS: Again, besides the frequency of the sequence that leads to core damage, you do not include anywhere the possibility of failure and you don't have any probabilities.

Things either work or you're assuming they're down. Is that correct?

MR. PRATO: In general, I think that that's an accurate statement. But the initial conditions, there's a tremendous amount of failure that need to be accounted for right up front.

MR. SCHAPEROW: Okay, so in conclusion for Surry, the scenarios identified generally we have a long time until core damage, as it relates to the environment.

The fastest scenario was the seismic-induced sequence we just discussed. Mitigation may prevent core damage for some scenarios. There's certainly more mitigation at the plants than there used to be, both with respect to procedures and equipment.

In some cases it looks like some of the PRA criteria we've used in the past, maybe on the conservative side with respect to crediting installed equipment and operator actions.

And the time to deploy this equipment, in many of these cases, does appear to be sufficient to prevent core damage, if the installed equipment is not available.

DR. ARMIJO: I see some, I don't understand long-term for this total loss of feed water we have. It would seem that the steam generators would completely boil dry in 30 minutes.

MR. SCHAPEROW: That total loss of feed event is a short-term station blackout which, which can --

DR. ARMIJO: No, I'm talking about the seismic event where you have total loss of feed water?

MR. SCHAPEROW: It takes a while to get to core damage for these. And if you have the boil out of the steam generators, then you have to start the boil off for the RCS and it takes a couple of hours.

DR. ARMIJO: So I guess I don't understand the meaning of the word long. What's long time in this line?

MR. SCHAPEROW: Well, we used to have large releases to the environment starting in about two hours or one and a half hours from the start of the event.

You'd have an initiator and an hour and a half or two hours later you start getting this large release into the environment. You know, we're not even getting core damage for, let's say four hours now, even for this fastest scenario.

You know, even, and once you get core damage, you don't automatically have a release. Then it has to, it has to heat up the RCS and, for Surry, the dominate path is to fail the vessel and the containment won't fail for a couple of days.

For Surry, you might get a tube rupture after several hours. But that's the less dominate path. But, it is long-term compared to, if you go back to the 1982 study, we had a release starting around two hours, after being initiated. That's quick.

MR. PRATO: Next is the structural on Surry, Ata, Slide 31, please.

MR. ISTAR: Again, we are trying to develop a leak rate as a function of pressure for reinforced concrete structure, like the one at Surry.

And, again, it's that leak rate is a function of pressure that's going to be used for the melt core analysis.

And looking back over 25 years of analysis and testing on reinforced concrete containment support hypothesis of the leak-before-break-failure condition.

Therefore, it is expected that the range of pressure needed to catastrophic rupture or burst can never be reached, since leakage should prevent catastrophic rupture.

And so this is one of our, you know, prerequisites to start analyzing the reinforced concrete containments.

And the next page is the approach, general behavior of concrete containment under gradual increase, increasing internal pressures.

First, as the pressure builds up inside containment, concrete will crack. Second, it will yield the liner. Then liner will tear, and a path of leakage is created.

And the third, yielding of hoop-reinforcement and enlargement of those tears. And, finally, reinforced concrete containment structures are predicted to have a significant leakage, rupture-like, once the global strain levels are reached at one to two percent.

I just want to define global strain. Global strain is located at mid-height level in the cylindrical section of the containment structure, away from the possible, you know, penetrations and other discontinuities. Next page, please.

And I, we took the NUREG-5121, as testing, one-scale model testing. I'm on six-scale modeling testing as a guide. And we developed these hoop-stress equations for different failure conditions for two percent strain, as well as rebar plus liner conditions.

Though we tried to adopt, tried to simplify analyses using these equations, whether it will match to the detail analysis was performed in the past, as well as to the testing. And, next page.

DR. APOSTOLAKIS: So what are analytical analyses?

MR. ISTAR: There are a lot of pre --

DR. APOSTOLAKIS: How can any analyses if they're not analytical?

(Laughter.)

MR. ISTAR: Well, computational. The term is used quite often.

DR. APOSTOLAKIS: It's really used? I thought that was a slip.

MR. ISTAR: Next page, next table, provides some results from different round robin analyses, as well as the test data. And a simplified analysis kind of highlighted in your table.

They are pretty consistent. And we believe that those simplified analyses conditions, using those simplified analyses conditions, using the one-scale reinforced concrete model results, we can come up with some kind of leak rate versus pressure curves.

Next page, please. Again, this stress strain was taken out of the NUREG-5121, showing the strain and the pressure rates at different, for liner, as well as the reinforcement.

Next page, please. During the test, the one-scale reinforced concrete model test, there were a lot of measurements made, leakage measurements made.

We provide the leak rate in different units percent mass per day, standard cubic feet per minute, as well as percent volume per day. And the one-sixth scale reinforced concrete model has a design pressure of 46 psig.

And the next page, the curve that is shown here, it is, again, for the one-sixth scale model. And it's, again, taken out of 5121. I, you know, do all of this, you know, they have a similar curve in the NUREG.

Next page, which is, they picked up some of the major reinforced concrete containment structures and tried to compare them whether they, you know, develop the same conditions.

And it appears that they are quite, you know, work well with the approach that we are taking here. And one thing I need to point out to you, Surry compared to Diablo Canyon, Salem and Seabrook, has a low modulus of elasticity of liner and rebar.

And liner plate yield was much lower. Rebar yield is much lower. And rebar, of course, two percent strain is much lower.

So, we're going to expect that the Surry, was going to have a lower, you know, pressure release. And which it's shown on the next page and the rest of the containment structures, including the one-sixth scale, have pressure over PD close to three in this case, and Surry would have about, right after two --

CHAIRMAN SHACK: Now the thick line is the predicted result and the thin line with the dots, are actually measurements?

MR. ISTAR: No, the thin line is what we believe what's going to happen. The thick line is the equation, fitted equation that I developed, that can be used in the melt core analysis.

Which, if you look at the upper right-hand corner, there's a Y equation three to the E minus some equation, I can't read it. But there's an R squared, which is .86.

CHAIRMAN SHACK: Okay, so the thin line is a detailed finite element analysis prediction?

MR. ISTAR: No, no. The thin line is our simplified analysis prediction. And thick line is the fitted curve for that line.

CHAIRMAN SHACK: Oh, it's a fitted curve to that line, okay.

MR. ISTAR: Correct, fitted curve for that line. And the equation for that fitted curve is up here on the upper, right-hand corner.

DR. APOSTOLAKIS: Why do you have here a plot of leak rate?

MR. ISTAR: Leak rate --

DR. APOSTOLAKIS: And then for the BWR you have the area.

MR. ISTAR: Right. It can, you know, it can be, you know, leak rate can be converted into area.

DR. APOSTOLAKIS: But it's just the same?

MR. ISTAR: Just the same thing. And, but in the reinforced concrete condition we have to kind of shift that curve based on several issues that I'm listing here.

Some kind of interim judgement needs to be done. For example, the temperature effect, degradation, like corrosion and aging effect, and original construction defects.

And during the site visits and I talked to their Chief Engineer related to that and we still going to talk about that, whether those conditions exist and how we're going to shift that curve somewhat as a percentage of the curve that we have seen on the previous page.

And which I'm showing as the last page, you know, those degradation effects and the temperature effects can, may be something like this. This is like, curve was done by Sandia, as to show how the simplified, the dark lines simplify things and we're just trying to push to include some of the site-specific conditions to shift that curve to the right side.

And that's probably going to come out

within some kind of engineering judgement.

CHAIRMAN SHACK: Why does increasing temperature lower the leak rate?

MR. ISTAR: Increasing temperature is not lowering the leak rate. That's a prediction, again. Don't take this curve as a final curve. It just, it was developed at Sandia and I just, you know, cut and paste here.

DR. ARMIJO: What temperature is this?

MR. ISTAR: The temperature in the containment that effects the liner reinforcement.

DR. ARMIJO: And this is independent of what the composition of the containment environment, as whether it's steam or air?

MR. ISTAR: It's, in this case it's irrelevant whether you have steam or air. It's temperature is the affecting, the liner, if the liner were subject to the high temperature, the properties of the liner, physical properties are going to go down drastically.

So, it's going to fail in the earlier, earlier than what we're predicting here. And if, eventually it's going to go through the concrete and effect the reinforcement.

And it's going to effect the

reinforcements as well, the temperature.

DR. ARMIJO: Okay, and I, I guess I really can't think of any physical rationale for why the leak rate would go down, as the temperature increases?

MR. ISTAR: No --

CHAIRMAN SHACK: Well, it's true for a gas, the viscosity will go up. But that's the only mechanism I can think of and I don't think that's very important here.

DR. ARMIJO: Right, no, you're right.

MR. ISTAR: It's not important.

DR. ARMIJO: Not to this extent.

CHAIRMAN SHACK: No, we'll just write it off to journal briefs or results.

MR. ISTAR: That's it.

MR. PRATO: Okay, anymore questions on the structural? That completes the staff's presentation. Any questions on any of the issues discussed?

DR. ARMIJO: I guess it would be nice to really get an explanation for this result, counter-intuitive.

CHAIRMAN SHACK: I mean, it shows the earlier collapse which is, you know, plausible. I'd certainly believe that. But why I have a lower leak rate up until the time that I finally go boom, is a little difficult to understand.

MR. ISTAR: That's a very good question, but that's, you know, I would think it's going to be higher, but I just, but again, this curve is just hypothetical.

If you look at our curve, it's very steep. It comes out at P over Pd, it's, it comes out like straight up and it's just going to be a curve and some percentage coming towards the right.

And this is kind of a, you know, --

CHAIRMAN SHACK: Until I manage to melt the core, this is all academic anyway.

(Laughter.)

MR. ISTAR: Yeah, show and tell.

DR. APOSTOLAKIS: Otherwise it's all national regulatory-like.

(Laughter.)

MR. PRATO: Any other questions?

CHAIRMAN SHACK: I think we're finished with the staff presentation. I'll open for discussion.

(Whereupon, the proceedings went back into Open Session.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards Regulatory Policies and Practices

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Charles Morrison
Official Reporter
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